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Will Carl Rufus
(1876-1946)

By FREDERICK EDWARD BRASCH*

W. Carl Rufus—astronomer—mathematician—philosopher—poet—administrator—teacher and friend, died at his summer home at Crooked Lake near Ann Arbor, Michigan, on Saturday, September 21, 1946, in his seventieth year. It does not always befall scholars to have such universal accomplishments as those attributed to Dr. Rufus. For they who hitch their wagons to the stars seem to sense further the meaning of the Pythagorean mystical numbers and the divine music of the spheres. These statements are based upon observations and experiences of nearly thirty years of friendship.

WILL CARL RUFUS
(1876-1946)

Dr. Rufus reflected a quiet demeanor through his sensitive blue eyes, revealing a soul pure and true, radiating a living religious spirit, loyal in friendship and wise in counsel. As a scientist his work will take a prominent place in the history of astronomy, and as a teacher the University of Michigan has lost a high ranking scholar.

W. Carl Rufus was the son of William J. and Eliza Ann (Connor), born July 1, 1876, at Chatham, Canada. His parents were citizens of the United States and therefore young Rufus sought his education here. He attended Albion College, Albion, Michigan, and graduated in 1902, with an A.B. degree. Upon graduation he married his college sweetheart, Miss Mauda Squire, on September 29, 1902, but he returned to college to

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secure his Master of Arts degree. He was first an assistant in mathematics at Albion College and later became an instructor of mathematics in the High Schools at Flint, Michigan (1902-1904) and at Lansing (1904-1905).

His deep religious feeling manifested itself in the meantime and during 1905-1907 he served as pastor of the Methodist Episcopal Church at Dryden and Owosso, Michigan. Rufus again returned to teaching when he accepted an assignment in 1907 as an instructor of mathematics and astronomy in Union College, Pyeng Yang, Korea. Two years later he became Superintendent of Education in M. E. Mission at Seoul, Korea. All through his later life he retained his ecclesiastical right to preach, and occupied pulpits as guest minister whenever called upon.

During 1913-1915, Rufus was a Fellow in Astronomy at the University of Michigan and secured his Doctorate. However, his intense love for the Orient soon called him back to Korea, when he received appointment as Professor of Mathematics and Astronomy in Chosen Christian College at Seoul. In order to receive the benefit of American educational opportunities for the three sons that now graced the family circle of Dr. and Mrs. Rufus, they returned to the University of Michigan and became residents of Ann Arbor.

Dr. Rufus received an appointment on the faculty of the University from the late Dr. William J. Hussey, then Director of the Observatory, first in 1917, as an instructor, in 1920 as Assistant Professor, and in 1934 as Associate Professor, and finally in 1941 as full Professor. These years were full, devoted to teaching, research and extra faculty duties.

Following the death of Ralph H. Curtiss and Heber D. Curtis, Directors successively of the Observatory, Dr. Rufus was called upon to act as Chairman of the Department of Astronomy and Acting Director in 1930-31 and again in 1938-39, and from 1942 until his retirement.

As a member of the University committee on Barbour scholarships, Dr. Rufus aided a large number of women students from Oriental countries. People interested him—they interested him sympathetically; hence he found much of interest and of goodness in the philosophy of the Orientals. He believed implicitly in the ultimate goodness of mankind. He derived great joy from world travel. This was shown when he became Professor of Mathematics and Astronomy in the University World Cruise in 1926-27. He was currently planning a trip to the Arctic Circle to see the midnight sun, which he had never observed.

His principal research work in astronomy included studies relating to atmospheric motion in stars of variable density and spectroscopic analysis of the composition of stars. He was one of the earliest research scholars to contribute to the new theory of Cepheid variables

and in the pulsating phenomenon. His research problems are set forth in precise analytical treatment and with résumé drawn in complete form. He gave special attention to, and reestablished a place of spectral type stars, Class R, in an evolution sequence. This work is to be found in the *Publications of the Observatory of the University of Michigan* (Vols. III, IV, VI), with shorter notices in POPULAR ASTRONOMY.

His historical interests found expression in establishing courses in the general history of astronomy. He was a pioneer in developing the first course of lectures in the history of Astronomy in America. Dr. Rufus was an able and clear lecturer and the synthetical treatment of historical epochs always revealed a profound knowledge of science, philosophy, and general history. As a fitting climax to his scholarly interests, and to his retirement as well, he was invited by the Princeton University Press to prepare a textbook on the "History of Astronomy." In this work he proposed to do justice to the history of astronomical research in the Orient. His authoritative knowledge of the ancient history of Chinese and Korean astronomy was revealed in a number of articles found particularly in POPULAR ASTRONOMY and Oriental publications.

However, his very special scholarly interest in historical matters was manifested in his writings on the life and work of David Rittenhouse (1732-1796), a colonial mathematician and practical astronomer of Philadelphia. Rufus was ever solicitous of advancing the work and reputation of his favorite colonial scientist, and it was this interest that brought the writer and Dr. Rufus together. We carried on a friendly rivalry in advancing the respective merits of David Rittenhouse and of Professor John Winthrop of Harvard College (1714-1779). (A part of the last paper prepared by Dr. Rufus follows this paper.)

In the philosophy of Rufus, science and religion had no conflict. He saw the spiritual value of scientific discoveries more than most scholars. This is clearly revealed in a paper published in *Social Science* for October, 1931. Here Rufus points out how great changes in recent scientific thought have deep philosophical and spiritual significance. His astronomical activities, combined with the essential mathematical formulas, did not detract from his religious convictions. Rather he brought science and religion into close harmony through his studies of the phenomena of the universe. Dr. Rufus was as much concerned with the human soul as he was with the mechanics of the heavens. He saw immortal truths out in the endless light years of space—he witnessed the operation of divine laws, laws that brought the stars and planets into being and produced life on at least one of the whirling spheres, and he was convinced that this universe was designed and ordered by a transcendental spirit called God. Dr. Rufus was indeed a devoted admirer of Sir Arthur Eddington and his philosophy.

In his poetry, mostly unpublished, he sums up his sincere religious convictions through a transcendental form resembling somewhat the philosophy of Emerson. Science and philosophy are the basis of Rufus' deep poetical feeling. One might say that the essence of Rufus' life and work were expressed in his poetry and his sermons.

How prophetic it seems! In the last sentence in the accompanying paper Rufus likens Rittenhouse's soul to that of Newton, whose philosophy and religion were correlated. So we can say the same for Will Carl Rufus. His soul was white.

David Rittenhouse as a Newtonian Philosopher and Defender

By W. CARL RUFUS

The natural philosophy of Sir Isaac Newton centered in his law of gravitation, the first great physical synthesis. It rationalized Kepler's empirical laws of planetary motion and united celestial and terrestrial phenomena. It established on a quantitative, measurable basis the mathematical principles of matter in motion, the dynamics of nature. Newton, however, did not deduce a mechanical, anti-religious philosophy from his law of gravitation. The ultimate nature of gravity remained unknown, also a final explanation of space and time and absolute motion in the physical realm. Combined with an accepted teleology this led to his famous theistic discourse in the second edition of the "Principia."

Cartesianism was strongly entrenched when Newton's philosophy appeared. Descartes had attempted to found a system free from the *occult qualities* of earlier philosophy and to base it on human experience in the dual realm of mind and matter. The essence of matter was extension: the physical universe knew no vacuum. Vortices in an invisible plenum of subtle matter moved the planets and satellites. This appeal to impulse and contact met with wide acceptance. Opponents of Newton maintained that his "gravity" was merely a name for something unknown, more unintelligible than Descartes' vortices, just as obscure as the occult qualities of the ancients.

In England, however, many mathematicians and astronomers cordially received the Newtonian theory. The most notable exception was John Flamsteed, first astronomer royal, who awaited improvements in the Lunar Tables based on the law of gravitation, and finally withheld his observational data from use in "Mr. Newton's crotchets." At one time he remarked somewhat peevishly, "Sir Isaac worked with the ore I dug"; to which Newton retorted, "If he dug the ore, I made the gold ring." On the continent Newtonian principles were rejected by

many, including Christian Huygens, Gottfried Wilhelm Leibnitz, and John Bernoulli. French Academy prizes were divided between Cartesians and Newtonians until 1740. The secretary, Fontenelle, died a stanch Cartesian in 1756. Three of the celebrated Cassini family, directors of the Paris Observatory, advocated for planetary orbits a special type of Cartesian curves, christened Cassinian ovals (traced by a point moving so the product of its distances from two fixed points is constant). They continued to defend the anti-Newtonian doctrine of a geoid, flattened at the equator, until the death of Cassini de Thury, 1784. This brings us to the fifty-second year of the life of David Rittenhouse, pioneer American astronomer and mathematician, the ablest Newtonian philosopher of the American colonial and revolutionary period.

Of the "philosophical trio of the revolution" Benjamin Franklin, John Winthrop, and David Rittenhouse, the last was the mathematician, *par excellence*. The late Professor Florian Cajori, reviewing the life and work of the mathematicians of the colonial period, said: "The mathematicians mentioned in the previous pages were all engaged in the profession of teaching. But, strange as it may seem, the most noted mathematician and astronomer of early times was not a professor in a college, nor had he been trained within college walls. We have reference to David Rittenhouse." (The Teaching and History of Mathematics in the United States, Bureau of Education, Circular of Information No. 3, 1890. p. 37.) Perhaps we should add that, although Rittenhouse was not an enrolled student, he had early contacts with the college at Philadelphia, and was appointed as Professor of Astronomy in 1779.

During boyhood on his father's farm he had evidenced great mechanical and mathematical ability, stimulated at twelve years of age by a chest of tools and books inherited from his uncle. According to James Renwick (Library of American Biography by Jared Sparks, p. 312, vol. VII, New York, 1853), among these books was an English translation of the "Principia" of Newton. Doctor Benjamin Rush in his Eulogy of Rittenhouse says: "It was during the residence of our ingenious philosopher with his father in the country that he made himself master of Sir Isaac Newton's "Principia," which he read in the English translation of Mr. Motte. It was here likewise he became acquainted with the science of Fluxions; of which sublime invention he believed himself, for a while, to be the author: nor did he know for some years afterwards, that a contest had been carried on between Sir Isaac Newton and Leibnitz for the honor of that great and useful discovery." His biographer, William Barton, quotes the above passage with approval (Memoirs of David Rittenhouse, Philadelphia, 1813, p. 120) in proof of Rittenhouse's genius, evidently accepting, as facts, the statements regarding the "Principia" and Fluxions. Renwick attempted to

explain the statement regarding fluxions as follows: "Newton, as is well known, from deference to the practice of the ancient philosophers, adopts in this work (the "Principia") the synthetic method of demonstration, and gives no clue to the analytic process by which the truth of his propositions was first discovered by him. Unlike the English followers of this distinguished philosopher, who contented themselves, for a time, with following implicity in the path of geometric demonstration, which he had thus pointed out, Rittenhouse applied himself to search for an instrument, which might be applied to the purpose of similar discoveries, and in his researches attained the principles of the method of fluxions. So ignorant was he of the progress which this calculus had made, and of the discussions in relation to its invention and improvement, that he for a time considered it as a discovery of his own. In this impression, however, he could not have long continued; as he made, in his nineteenth year, an acquaintance, who was well qualified to set him right in this important point." He refers, of course, to the Reverend Thomas Barton, an Episcopal clergyman, graduate of Dublin University, who taught in the Rittenhouse neighborhood, and became acquainted with the family when David was nineteen years of age. Renwick adds later, "Desirous to peruse his admired Newton in the original dress, Rittenhouse now applied himself to the study of the Latin language, which he speedily mastered," and again "He persevered until he had, step by step, mastered all the truths of mathematical science, and had arrived at the principles of that calculus, for the honor of whose invention a Newton and a Leibnitz had contended."

No evidence is available to show that Rittenhouse did any original, independent work in fluxions. It is clear, however, that he acquired a complete mastery of the mathematical principles of Newton and was able to apply them in numerous complicated problems.

His first published article, 1767, was to correct an error made by a writer in the *Pennsylvania Gazette*, who tackled the problems of Archimedes, "Give me a place to stand on, and I will move the Earth." The author's conclusion was that a weight of two hundred pounds would move the earth one inch in twenty-seven billion years. Rittenhouse replied, October 8, 1767, in part as follows:

"If a ball of earth, weighing two hundred pounds, were left at liberty near the surface of this globe, it would descend, by its own gravity, about fifteen feet in one second of time, and about twenty miles in eighty seconds. And if, as this gentleman supposes, there are about two thousand trillions of such balls in the whole earth,—the Earth, by their mutual attractions, in eighty seconds of time, will move toward the ball 1/1,736,000,000,000,000 of an inch; and if the same force were to act continually for one hundred and five years, it would move about one inch, and it must, from the velocity received by

that force alone, continue forever after to move at the rate of one inch in about fifty years."

The delay in the reply of Rittenhouse may have been due to his desire to obtain correct data. He used the author's values, however, "Without being at the trouble to examine his numbers." The velocity of a falling body and the "weight" of the earth, are both somewhat erroneous. He evidently used correct formulas for the space traversed and velocity acquired and was familiar with the principle that the velocity at which a body falls depends on the weight (mass) of the attracting body and is independent of its own. Using fifteen feet for the distance fallen during the first second, due to the earth's gravity, the distance in eighty seconds would be $15 \times 80 \times 80/5280$, or $200/11$ miles, which is given by Rittenhouse as about twenty miles. It is evident, however, that he used the former value and the ratio of "weights" to obtain the distance the earth moved toward the ball, which checks to the last significant digit of his result. The other values given are consistent and testify to the accuracy of the method and computation. As he wished neither notoriety nor controversy the article was signed, *A Mechanic*.

On one occasion, in spite of reticence, Rittenhouse came forward to defend the Newtonian philosophy. In Colonial America Newton's system was well received in general. An opponent in 1776 gave this explanation (*Pennsylvania Magazine*, Vol. 2, p. 123, 1776): "Perhaps Sir Isaac, having been an Englishman, and certainly one of the greatest geniuses the world ever admired, may be a reason why the English and the Americans (who have too long danced after them) do almost implicity receive that system as infallible." This writer, M. W., (supposed to be the Reverend Matthew Wilson) quotes John Locke's attitude. "It is evident, that by mere matter and motion, none of the greatest phenomena of nature can be resolved; to instance but in that *common one of gravity*, which I think impossible to be explained by any natural operation of matter, or any other law of motion, but *the positive will of a superior Being* so ordering it." M. W. then proceeds in two numbers of the *Pennsylvania Magazine* to expound Cartesianism and to denounce Newtonian philosophy, chiefly from a metaphysical standpoint. Rittenhouse did not reply. Perhaps emboldened by this attack another correspondent (J. W.) contributed "A Few Thoughts on Space, Dimension, and the Divisibility of Matter in Infinitum" (*Ibid.*, p. 225-229) which incited a response.

Rittenhouse began his article "The Newtonian Philosophy Defended" (*Ibid.*, 282, 283) with the following remark, very penetrating if not truly prophetic: "I am one of those who are ready to subscribe to the general maxim, that perfection is not to be found in anything human; and therefore do not suppose the Newtonian philosophy to be so perfect as not to admit of amendment." Over two centuries elapsed, however, before an amendment, relativity, was seriously considered. Rit-

tenhouse continues, "But I must confess that almost all the attempts to controvert that philosophy, which I have met with, amount to nothing more than so many proofs that those who made them did not understand it. Of this kind are the objections stated by your correspondent J. W. I shall neither spend my own time, nor trouble you with pointing out at present more than one of the several mistakes he has fallen into. He endeavors to prove, either that extension is not infinitely divisible, or that a fundamental principle of the Newtonian philosophy is not true. "For, says he, 'if the power of gravitation between bodies be [inversely, he ought to have said] as the squares of their distances; and if at any given distance (no matter whether we call it a yard or a thousand miles) the power of their tendency towards each other is equal to any given number; then at half that distance, the power will be four times as much, and so on. Hence it must follow, that if that distance is divisible into infinite parts, that power of attraction between them will increase infinitely beyond all calculation: But this is grossly false in fact; for we know when bodies come into actual contact, by means of this supposed power, their resistance to separation again, or tendency to unite, is very limited, and easily overcome by an excessively finite power. Therefore as at contact, which is the end of distance, the power of attraction is finite, of consequence the spaces they traverse before they meet cannot be infinitely divisible. And no demonstration, no not a mathematical one, can be true which implies a flat contradiction.'

"This gentleman would have found no contradiction at all in the case, if he had remembered, as he ought to have done, *First,* that the Newtonian philosophy informs us that the force of attraction between regular bodies is inversely as the squares of the distances of their centers; and not in any case inversely as the distances of their nearest surfaces, which his argument supposes. *Secondly,* that as soon as the center of one body enters the surface of another homogeneous body, this rule ceases, and another, more simple, takes place, *viz.,* the force of attraction decreases, directly as the distance of the centers decreases. I say, if he had considered this, he would have seen that he could not, by any infinite divisibility of extension, produce an infinitely *great* force of attraction; though he might a force less than any assignable. I wish the gentleman would be more cautious for the future; as well on his own account, as for the sake of your readers, some of whom may be misled by the weakest reasoning, on a subject which they do not understand. And I will venture to assure him, that the whole doctrine of infinites, which he is pleased to call a sophism, will not produce one contradiction in a mathematical head. Those of another cast need not meddle with it; since there are a sufficient variety of literary subjects to engage every man according to the bent of his genius."

A noted achievement of Rittenhouse in theoretical and practical

astronomy was connected with a transit of Venus. About a year before the event, he contributed to the American Philosophical Society a "Calculation of the Transit of Venus over the Sun, which is to happen June 3, 1769" (*Trans. A. P. S.*, **1**, 4, 1771). Elements were used from Halley's Tables, for latitude 40° north and longitude 75° west from Greenwich, and the path laid down for an observer at Philadelphia. On the practical side, he erected an observatory on his farm, determined its latitude and longitude and equipped it chiefly with instruments of his own construction, including an equal altitude instrument, a transit telescope, and an excellent clock, that "does not stop when wound up," which he carefully and accurately rated (*Trans. A. P. S.*, **1**, 13-23). His observational work on the day of the transit, described in an "Account of the Contacts" (*Trans. A. P. S.*, **1**, 26-68), included an excellent description of a phenomenon rightly interpreted by him as the effect of an atmosphere of Venus. He also took an active part in the reduction of the observations for the determination of the solar parallax. Provost William Smith presented the paper: "The Sun's Parallax deduced from a comparison of the Norriton and some other American Observations of the Transit of Venus, 1769; with the Greenwich and other European Observations of the same" (*Trans. A. P. S.*, **1**, App. 54-70), but we recognize in it the work of Rittenhouse. Moreover, Smith gives credit to him for an important part of the method. This is confirmed by an unpublished letter from Rittenhouse to John Page, exhibited at the bicentenary celebration by Mrs. W. E. Montague, in which he says: "In page 59 of the appendix to the astronomical papers in our Transactions, Dr. Smith has given my method of determining the angle in question." In the letter he also calls attention to an error in the theory applied by Ewing and by Williamson, which introduced an excess of four or five minutes in the angle mentioned which was the obliquity of the "visible way" of Venus. He attributed the error in theory to an unnamed publication in England before the transit. His detection of the error and its correction by substituting his own method in the reduction of the Norriton results indicate a complete mastery of the theoretical side of the problem. Chief dependence was placed upon data obtained at the external contact for two reasons: in Europe the altitude of the sun at internal contact was rather low (being less than 5° at Greenwich) and the black drop which develops at the second contact also rendered the time uncertain. Various values of the solar parallax were deduced from different combinations, some of which have been frequently quoted. The first Greenwich-Norriton value from external contacts was 8".8715. Attention was previously called (*Sci. Mon.*, **19**, 125, 1924) to a value obtained apparently as an afterthought, probably due to Rittenhouse. Smith says: "There is one small nicety, which the extreme strictness of the modern astronomy might have required to be taken into the forego-

ing calculations: and which was not thought of in time." He then introduced a correction in the latitude of Norriton and of Greenwich due to the earth's oblateness and its effect on the equatorial parallax. The revised value from the Greenwich-Norriton external contacts was 8".805, which is in striking accord with the present adopted value 8".80; the third decimal place is yet uncertain, but is probably a little greater than 2, obtained by Newcomb's combination of observations, and may be provisionally placed at 3. Encke's value (1835) from the transit observations was 8".571. We may admit that there was a fortuitous element in the Norriton result, but it is also worthy of note that such happenings are usually limited to the most careful and rigid scientific investigators.

On November 9, 1769, following the transit of Venus, Rittenhouse, with Smith, Lukens, and Biddle, at the Norriton Observatory observed a transit of Mercury (*Trans. A. P. S.*, **1**, App. 50-54). In spite of clouds, the bane of astronomers, they succeeded in observing the first external contact and the first internal contact, and made several micrometric measures of distance from the sun's limb. The results indicated that a slight correction was necessary in Halley's theory of the orbit.

During June and July of 1770, Rittenhouse made observations on Lexell's comet with a common Hadley quadrant (which Jefferson preferred to call a Godfrey quadrant), computed the parabolic elements of its orbit, "the fruit of three or four days labor, during which I have covered many sheets, and literally drained my ink-stand several times" (*Trans. A. P. S.*, **1**, App. 37-45). So accurate were the observations and the "very laborious computations" that his results were in close agreement with those of its discoverer, Messier in France, whose observations began about two weeks earlier, and with those of Dix in England.

In this work he seems to have surpassed the achievement of Winthrop of Harvard. In a letter to Barton regarding the comet, July 30, he says: "I can assure you that the account from York, of its having been seen again near the place where it first appeared, is a mistake. Nor is Mr. Winthrop of Boston happier in supposing that it yet crosses the Meridian, every day, between twelve and one o'clock, that it has already passed its perihelion, and that it may, perhaps, again emerge from the Southern Horizon. This Comet is now to be looked for no where but a little to the North of, and very near to the ecliptic. It rises now a little before daybreak, and will continue to rise sooner and sooner every morning."

His last paper "To determine the true Place of a Planet, in an Elliptical Orbit, directly from the mean Anomaly, by Converging Series" (*Trans. A. P. S.*, **4**, 21-26), was presented February 5, 1796, only a few months before his death.

In his annual oration on astronomy before the American Philosophi-

cal Society on February 24, 1775, Rittenhouse ardently supports the philosophy of Newton, both natural and metaphysical, and expresses himself in no uncertain terms against atheists and skeptics. After reviewing the history of astronomy to the time of Newton, he says: "It was Newton alone that extended the simple principle of gravity, under certain just regulations, and the laws of motion, whether rectilinear or circular, which constantly take place on the surface of this globe, throughout every part of the solar system; and from thence, by the assistance of a sublime geometry, deduced the planetary motions, with the strictest conformity to nature and observation.

"Other systems of Philosophy have been spun out of the fertile brain of some great genius or other; and for want of a foundation in nature, have had their rise and fall, succeeding each other by turns. But this will be durable as science, and can never sink into neglect, until 'universal darkness buries all.'

"Other systems of Philosophy have ever found it necessary to conceal their weakness, and inconsistency, under the veil of unintelligible terms and phrases, to which no two mortals perhaps ever affixed the same meaning; but the Philosophy of Newton disdains to make use of such subterfuges; it is not reduced to the necessity of using them, because it pretends not to be of nature's privy council, or to have free access to her most inscrutable mysteries; but to attend carefully to her works, to discover the immediate causes of visible effects, to trace those causes to others more general and simple, advancing by slow and sure steps towards the great First Cause of all things (Barton, App. 560).

"Nothing can better demonstrate the presence of the Deity in every part of space, whether vacant or occupied by matter, than astronomy does. It was from an astronomer St. Paul quoted that exalted expression, so often since repeated, 'In God we live, and move, and have our being.' His divine energy supports that universal *substratum* on which all corporal substances subsist, that the laws of motion are derived from, and that wings *light* with angelic swiftness.

"If the time would permit, how agreeable the task to dwell on the praises of astronomy: to consider its happy effects, as a science, on the human mind. Let the skeptical writers forbear to lavish encomiums on their cobweb Philosophy, liable to be broken by the smallest incident in nature. They tell us it is of great service to mankind, in banishing bigotry and superstition from amongst us. Is this not effectually done by astronomy? The direct tendency of this science is to dilate the heart with universal benevolence, and to enlarge its views. But then it does this without propagating a single point of doctrine contrary to common sense, or the most cultivated reason. It flatters no fashionable princely vice, or national depravity. It encourages not the libertine by relaxing any of the precepts of morality; nor does it attempt to undermine the foundation of religion. It denies none of those attributes,

which the wisest and best of mankind, have in all ages ascribed to the Deity: Nor does it degrade the human mind from that dignity, which is ever necessary to make it contemplate itself with complacency. None of these things does astronomy pretend to; and if these things merit the aim of Philosophy, and the encouragement of a people, then let scepticism flourish, and astronomy lie neglected; then let the names of Berkeley, and Hume, become immortal, and that of Newton be lost in oblivion" (*Ibid.*, App. 569-570).

Coupling the names of Berkeley and Hume in a peroration against the skeptics seems somewhat baffling. George Berkeley, Irish bishop and philosopher, came to America in 1728, with the idea of establishing a college in the Bermudas. In general the essence of his metaphysics agreed with Newton and Rittenhouse. "A living active Mind is looked upon as the center and spirit of the universe." All nature is the language of God. In a vigorous Christian apologetic, however, he directed a polemic against the fundamental conceptions of the infinitesmal calculus and attacked higher mathematics as leading to free thinking. Therefore, the protest of Rittenhouse. David Hume, on the other hand, in his ontology, attacked the Newtonian doctrine of the infinite divisibility of space and time and maintained that the ultimate elements of conscious human experience must be real units, capable of being represented or imagined in isolation. In Rittenhouse's Defense of the Newtonian Philosophy, previously given, the doctrine of infinite divisibility was upheld.

Christians or free-thinkers could not attack Newton with impunity before his gallant defender. Perhaps it was this impartial attitude that gave the impression to some that Rittenhouse was not a believer in the Christian religion (see Memoirs, page 596). His testimony, however, through life and at death gave evidence of his religious devotion. Like Newton, whose philosophy he adopted, his soul was white.

Periodic Comet Wolf I

By N. T. BOBROVNIKOFF

This faint periodic comet (the present period is about 8 years) illustrates so many points in the theory of comets, both physical and orbital, that it is worth while to consider it in detail. The comet may be irretrievably lost unless the observers make a determined effort to find it in 1950.

It was discovered by Max Wolf[1] in 1883 and was observed as Comet 1884 III, 1891 II, 1898 IV, 1912 I, 1918 V, 1925 XI, 1934 I, and 1942*f*. The orbital theory of this comet was first worked out by the Reverend Mr. Thraen,[2] a well-known computer of cometary orbits. It was later taken over by M. Kamienski[3] who published a large number

of memoirs devoted to this comet. The result is that we know its motion as far back as 1800, and it is undoubtedly the best investigated comet besides Encke's Comet.

The first four apparitions of the comet so far as its brightness and diameter are concerned were investigated in some detail by J. Holetschek[4] who came to the conclusion that in 28 years the comet did not change appreciably either in brightness or diameter. Holetschek's conclusions are confirmed in this paper. Nevertheless, there is no question that more recent apparitions indicate a very substantial drop in the brightness occurring between 1925 and 1934.

As the basis for the present investigation we adopt the data for the apparition 1918-19. The brightness of the comet was estimated by Barnard[5] with the Yerkes 40-inch refractor on 28 nights over a period of 264 days. To be sure these were simple impressions of the total brightness, and not actual comparisons of the comet with known stars for which a photometric scale had been established. Considering, however, the reputation of Barnard as a visual observer we may assume that his estimates would at least be consistent among themselves, even if the zero-point of his visual scale would differ from that of other observers. We have an opportunity also for this apparition to compare Barnard's scale with that of Van Biesbroeck[6] who on many occasions established that his own visual scale is very nearly that of the Harvard Visual System.

We shall try to represent Barnard's observations by the usual formula

$$J = J_o/\Delta^2 r^n$$

where J is the apparent brightness of the comet, J_o is a constant, Δ is the geocentric distance, and r is the heliocentric distance. The exponent n is to be determined from the observational data. In the logarithmic form we have

$$H = H_o + 5 \log \Delta + 2.5\ n \log r.$$

We shall call

$$H_\Delta = H - 5 \log \Delta$$

the reduced brightness and H_o the absolute brightness of the comet. Barnard's estimates and other quantities are given in Table 1.

TABLE 1

BRIGHTNESS OF COMET WOLF I 1918-19

Date		H (m)	log Δ	H_Δ (m)	log r	o—c (m)
July	11	14	0.141	13.30	0.337	—0.43
"	16	14	0.125	13.38	0.331	—0.31
"	18	14.5	0.117	13.92	0.329	+0.25
"	30	14	0.088	13.56	0.315	+0.01
Aug.	1	14.5	0.082	14.09	0.312	+0.56
"	6	13.5	0.071	13.15	0.307	—0.34
"	27	13	0.035	12.82	0.282	—0.46

Date		H (m)	log Δ	H_Δ (m)	log r	o—c (m)
Sept.	5	13.5	0.027	13.37	0.271	+0.17
"	7	14	0.025	13.88	0.268	+0.71
"	12	13	0.022	12.89	0.263	—0.24
"	19	13.5	0.021	13.40	0.255	+0.33
"	26	13	0.022	12.89	0.247	+0.39
Oct.	3	12.5	0.025	12.38	0.240	—0.56
"	8	13	0.028	12.86	0.235	—0.04
"	29	13	0.054	12.73	0.217	—0.04
Nov.	5	13	0.065	12.67	0.212	—0.06
"	23	13.5	0.101	13.00	0.203	+0.36
"	30	13.5	0.115	12.93	0.201	+0.30
Jan.	18	13.5	0.232	12.34	0.210	—0.36
"	25	13.5	0.249	12.25	0.215	—0.46
"	28	14	0.256	12.72	0.217	—0.04
Feb.	1	14	0.262	12.69	0.220	—0.09
"	4	14	0.264	12.68	0.222	—0.12
"	15	14	0.299	12.50	0.232	—0.38
"	18	14.75	0.306	13.22	0.235	+0.31
"	25	15	0.322	13.39	0.242	+0.43
Mar.	18	15	0.367	13.16	0.265	+0.01
Apr.	1	15.5	0.394	13.53	0.281	+0.25

The least squares solution yields

$$H_o = 10^m.99 \pm 0^m.28$$
$$n = 3.25 \pm 0.46.$$

The difference between the observed magnitude of the comet and the computed magnitude is given in column o—c. A plot of H_Δ against log r (Figure 1) reveals no systematic difference between the pre- and post-perihelion observations of total brightness (T Dec. 13, 1918), so that we may treat all observations as a whole.

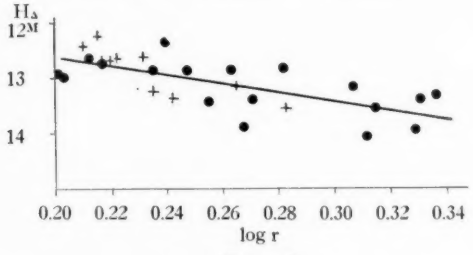

FIGURE 1

Correlation of reduced brightness of the comet and logarithm of the radius vector 1918-19. Filled circles are observations before perihelion, crosses are observations after perihelion. The straight line represents the least squares solution.

The probable errors are compounded of both the errors of estimates and the possible intrinsic variation in the brightness of the comet. In 1883 the comet was strongly variable and one of the observers[7] describes it as similar to the notoriously variable Comet 1884 I (Pons-Brooks) observed at the same time. In 1891 the variation in brightness was also noticed by several observers, and Spitaler[8] describes it as

"striking." These variations in brightness apparently were not so pronounced at later apparitions.

It should be noticed also that the evaluations of photometric parameters for comets with large perihelion distances (1.58 A.U. in the present case) is uncertain. The variation in log r between r = 0.1 and 1.0 A.U. is the same as between 1.0 and 10.0 A.U. In our case even though the comet was observed for an unusually long time, the whole variation in log r was only 0.136 A.U. So far as the variation in the brightness as a function of the radius vector is concerned, we have from the above formula

$$\partial H/\partial r = 2.5\, n/r.$$

That is, the intrinsic variation is inversely proportional to the radius vector. In our case the total amount of variation in H was $3^m.0$ but the variation in H_Δ was only $1^m.8$.

Taking all this into consideration, the photometric parameters from Barnard's observations are as good as might be expected, and much better than average for a comet with such a large perihelion distance.

Van Biesbroeck's five observations with the 40-inch are systematically above Barnard's curve by $0^m.20 \pm 0^m.07$. Van Biesbroeck thus estimated the total brightness of the comet $0^m.2$ brighter than Barnard. This difference is surprisingly small.

However, if we take Van Biesbroeck's four observations made with the 12-inch refractor the situation is quite different. They are above Barnard's light curve by $1^m.48 \pm 0^m.10$. We deal here with the systematic difference in the estimate of the total magnitude of the comet depending primarily on the aperture of the telescope. This problem has been treated by me previously in considerable detail.[9] That there is such a difference in the present case is evident from Barnard's observations alone. While estimating the total magnitude of the comet to be 13.5 he still could see it in a 4-inch finder. This would be quite impossible if the comet were really $13^m.5$. In the usual formula representing the average conditions for telescopes the limiting stellar magnitude (m) is given

$$m = 8.8 + 5 \log d,$$

where d is the aperture of the telescope in inches. For the finder we have then $m = 11^m.8$, and comets become invisible in the telescope long before the limiting stellar magnitude is reached. For this comet, Van Biesbroeck estimated the magnitude as 13.5 when it was on the limit of visibility in the 12-inch telescope, for which the stellar limiting magnitude by the above formula is 14.2. I found it almost impossible to see Comet 1942 *g* in a 9.5-inch telescope when its brightness was estimated as $11^m.3$, whereas stars of $13^m.6$ were still visible. If Barnard tried to estimate the total magnitude of Comet Wolf I in the 4-inch finder he would have found, probably to his surprise, something like 10^m. In

fact the comet was seen by Vanderlinden[10] through a 3-inch finder for which the limiting stellar magnitude is 11.3. Vanderlinden himself on that occasion estimated the brightness of the comet $12^m.5$ through a 15-inch telescope.

All observers of this comet, Van Biesbroeck (12-inch), Vanderlinden, Chofardet,[11] and A. Abetti,[12] show very large differences in relation to Barnard's estimates made with the 40-inch. The corrections, ΔH, to these observations in order to reduce them to Barnard's scale are given in Table 2 where N refers to the number of observations made.

TABLE 2

SYSTEMATIC CORRECTIONS TO REDUCE TO BARNARD'S SCALE

Aperture	Observer	N	ΔH	p.e.
			$_m$	$_m$
12.0 in.	Van Biesbroeck	4	+1.48	±0.10
13.0	Chofardet	7	+2.56	0.19
14.4	Abetti	7	+1.87	0.04
15.0	Vanderlinden	3	+0.85	0.22

The large correction to Chofardet's observations may possibly be due to his use of a finder to estimate the brightness, and of the 13-inch telescope for micrometric measures, but nothing is said about it in his paper. This is a very common and very unfortunate trait of observers who seldom supply sufficient information for a precise study of physical characteristics of comets.

There are also four estimates of the brightness of the comet made by R. Jonckheere[13] with the 28-inch refractor of Greenwich. They are below Barnard's curve by $0^m.18 \pm 0^m.24$, or, in other words, there was no systematic difference between Jonckheere and Barnard. However, for the observations on the same night Jonckheere's tabulation gives the difference in the opposite sense, $0^m.3$, as one would expect. We may note also that his observations show a variability of the comet. He gives $15^m.5$ for July 9, next night $15^m.0$, and $14^m.2$ for July 12, that is, an increase of $1^m.3$ in 72 hours. This is quite impossible to reconcile with the light curve of the comet based on Barnard's observations and supported by other observations if properly corrected.

In regard to the systematic corrections given in Table 2 we may note that they illustrate the fallacy of the common explanation as to why the use of larger instruments nearly always results in fainter estimated magnitudes of comets: in larger instruments only the central part of the comet is observed. In the interval covered by Chofardet's observations, August 28 to November 23, he estimated the average apparent diameter of the comet to be 37″, while Barnard in the same interval found the diameter 55″, Abetti 30″, Vanderlinden 90″, and Van Biesbroeck 60″. We see that both Chofardet's and Abetti's estimates of the diameter were much smaller than those of Barnard, while their estimates of magnitude were $2^m.56$ and $1^m.87$ brighter.

The size of the corrections to the various observers in Table 2 shows

the futility of indiscriminate combination of all observations of comets without a careful study of systematic errors. Especially important is this for comets like Encke's which first are observed with large instruments and gradually, with approach to the sun, become visible to the naked eye. For Comet Wolf I the value of n is 3.25, almost identical with the average value found by me for 45 photometrically observed comets. Such values of n as 6 found by Van Biesbroeck[14] for Encke's Comet in 1924, or 16 found by N. Richter[15] for Tuttle Periodic Comet (1939 X) and 12 for Pons-Winnecke Periodic Comet (1939 V), or, finally, 74 obtained by Vorontsov-Veliaminov[16] for Tempel 2 (1925 IV) would indicate a real difference in behavior between the short-period and other comets. These results, however, are almost certainly due to lack of attention to systematic errors.

For the apparition of 1918-19 of Comet Wolf I we also have an opportunity to determine the color index, however indefinite this concept may be in connection with comets. The two photographic observations by Schorr[17] and one by Wolf[18] give the values o-c $-0^m.21$, $-0^m.43$, and $+0^m.07$ in reference to the light curve based on Barnard's visual observations. The average color index is then $-0^m.19$. How little this really means can be seen from the fact that in reference to Chofardet's visual observations the same color index should be $-2^m.37$. To draw any conclusions from these figures as to the color and temperature of the comet is obviously impossible.

The observations of the brightness in 1918-19 are represented in Figure 2 in which the light curve is based on Barnard's observations alone. All other observations were corrected by the amounts given in Table 2.

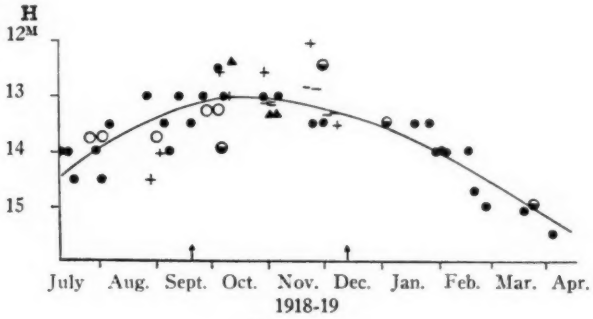

FIGURE 2

Light curve based on Barnard's observations 1918-19 (filled circles). Van Biesbroeck 40-inch (open circles), 12-inch (half filled circles). Abetti (dashes), Chofardet (crosses), Vanderlinden (triangles). First arrow indicates the closest approach to the earth; second, perihelion.

In 1911 the comet was observed by Barnard,[19] also with the 40-inch telescope, on seven nights, July 21 to September 19. The variation in

the radius vector was so small that it is out of the question to determine the exact value of the exponent n. In fact if we reduce Barnard's observations with different exponents we have Table 3.

TABLE 3

ABSOLUTE BRIGHTNESS IN 1911

n	H_0	p.e.
	m	m
2	11.50	±0.14
3.25	10.30	0.14
4	9.60	0.15

Table 3 shows that the value of the absolute magnitude depends very strongly on the exponent used, but a wide variation in n gives consistent results. The exponent $n = 3.25$, derived for the apparition 1918-19, has been adopted for all other apparitions of Comet Wolf I.

For the apparition of 1925 we have eight observations by Van Biesbroeck[20] between July 12 and November 12 made with the 40-inch refractor. These observations give $H_0 = 11^m.02 \pm 0^m.11$, which reduced to Barnard's scale (by the apparition 1918-19) becomes $11^m.22 \pm 0^m.11$. Van Biesbroeck's photographic observation of December 19 indicates $H_0 = 12^m.03$, or a color index of +1.01. However, photographic observations by Jeffers[21] at about the same time give a color index of about $-1^m.0$, so that the question of the color index is again rather meaningless. Perhaps the comet varied in brightness, both visually and photographically at this time. The values of H_0 derived from Barnard's and Van Biesbroeck's observations for these three apparitions are the only exact material at our disposal to form judgment as to the disintegration of the comet. We notice that there was a slight drop in the brightness of the comet between 1911 and 1918 amounting to about $0^m.7$, but there was practically no change between 1918 and 1925 in spite of very large changes in the orbit. The rest of the data on the brightness of this comet cannot be combined with the data of 1911 to 1925 unless we make some rather questionable assumptions.

For the year 1891 we have an excellent series of estimates by Holetschek,[22] sixteen in number, made between August 12 and December 2. They were made with a 1.5-inch finder, are quite consistent, and give $H_0 = 7^m.68 \pm 0^m.07$. But what is the reduction from the 1.5-inch finder to the 40-inch telescope? There is no way of establishing it directly. Hotelscheck's scale was approximately Harvard's, and so was Van Biesbroeck's. Applying to this case the average reduction $0^m.167$ per one inch aperture,[23] we find a correction to Hotelscheck $+1^m.75$ to reduce his data to Van Biesbroeck's estimates made with a 12-inch telescope. The reduction of Van Biesbroeck's estimates to those of Barnard's with the 40-inch was found to be $+1^m.48$. The total correction is then $3^m.23$, and Hotelschek's value of H_0 becomes $10^m.91$ on the Barnard 40-inch scale, or almost identical with that of 1918.

There are several very discordant estimates of brightness made at the first apparition in 1884, from which nothing certain can be derived. We may accept Holetschek's opinion that there was no marked change in the brightness between 1884 and 1891, and put H_0 for 1884 at $10^m.9$.

In 1898 the comet was poorly observed, but from Abetti's seven observations we obtain $H_0 = 8^m.84 \pm 0^m.05$. Applying the correction $+1^m.87$ to reduce his observations made with the 14-inch telescope to Barnard's 40-inch, derived for 1918, we obtain $H_0 = 10^m.71$, again almost identical with several preceding and following apparitions.

In 1933-34 the comet was observed only photographically on Mt. Hamilton.[24] On August 25, 1933, Mayall measured its brightness as $18^m.4 \pm 0^m.2$, and on September 14, 1934, as $19^m.1$. These estimates give $13^m.4$ for H_0 in both cases. The comet was observed by Jeffers several times between July 25 and November 11, and it was always of 18^m. This apparent magnitude gives a variation in H_0 between $12^m.7$ and $12^m.9$.

In 1942 the comet was photographed by Baade with the 100-inch telescope and its brightness was found to be $18^m.6$. This results in $H_0 = 14^m.18$, or almost a magnitude fainter than in 1933.

Collecting all these results we have on Barnard's scale with the 40-inch telescope Table 4.

TABLE 4

ABSOLUTE MAGNITUDE AND DIAMETER OF WOLF I

Year	H_0 m	$\overline{D}$	N
1884	(10.9)	74.0	45
1891	10.9	74.2	54
1898	10.7	93.8	4
1912	10.3	20.1	15
1918	11.0	57.7	29
1925	11.2	12.1	4
1934	(13.4)	5.5	2
1942	(14.1)	..	..

The uncertainty in the color index of the comet relative to the visual scale of the 40-inch telescope may be one full magnitude. It is, however, rather evident that the comet remained stationary in brightness from 1884 to 1925, and dropped in brightness by at least one magnitude between 1925 and 1934.

Table 4 gives also the average diameter of the comet ($\overline{D}$), in thousands of kilometers and the number of observations (N) included in the mean. It would seem that we have here a striking example of the gradual diminution in the diameter, but the situation is far more complex than this simple explanation would suggest.

If we separate the pre- from the post-perihelion observations of the

diameter, and take means through every 0.2 of the value of the radius vector we have Table 5.

TABLE 5

VARIATION IN THE DIAMETER OF COMET WOLF I

Before Perihelion			After Perihelion		
$\overline{r}$	N	$\overline{D}$	$\overline{r}$	N	$\overline{D}$
..	..	..	3.04	2	35.6
2.70	4	12.4	..	..	..
2.52	11	12.1	2.44	8	62.7
2.33	4	7.7	2.29	6	40.3
2.12	5	18.5	2.09	7	87.5
1.92	6	23.7	1.93	8	79.7
1.65	29	85.8	1.67	19	85.5
1.59	39	68.0	1.59	6	100.1

The data of Table 5 are represented in the diagram, Figure 3. We

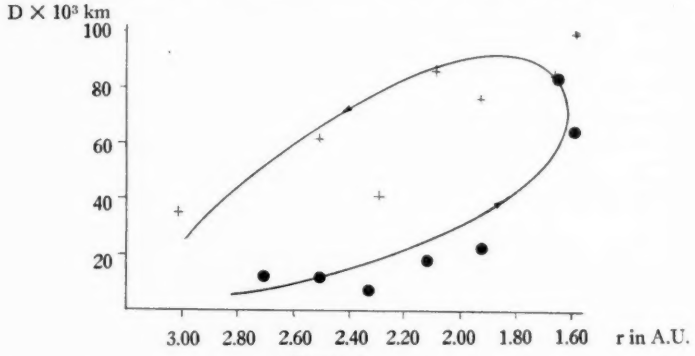

FIGURE 3

Variation in the diameter of the comet as a function of heliocentric distance. Filled circles refer to observations before perihelion, crosses to observations after perihelion.

notice a definite correlation between the observed diameter of the comet and its distance from the sun, but not in the way commonly supposed: the diameter is greatest at perihelion, diminishing on either side of it. The diameter is systematically greater after perihelion than before. The last point after perihelion is based on only two observations and is therefore rather uncertain. In all probability the difference between the pre-perihelion and post-perihelion diameters diminishes with increasing distances and the two merge at about $r = 4$ A.U.

This behavior of the comet cannot be explained by observational selection. Since the perihelion of the comet nearly coincides with the vernal equinox point ($\pi = 19°$ for 1918), the perihelion opposition of the comet occurs early in October. In 1918 when the perihelion was passed on December 13 the conditions of visibility were therefore much better before that date than after. In fact in February and March,

1919, the comet was never farther than 60° from the sun, so that it was projected on a bright sky. Nevertheless the diameter after perihelion was much greater than before perihelion for about the same variation in the heliocentric distance, namely 99,000 km and 41,000 km.

As there was no systematic difference in the total absolute magnitude of the comet before and after perihelion, it follows that the surface brightness of the comet is much lower after perihelion than before. Something of this sort was actually observed[7] in 1884.

In connection with the possible disintegration of the comet, we must consider two other features which at present cannot be accounted for. These are the close approach to Jupiter and the change in its mean daily motion.

O. Callandreau[25] in his memoir on the stability of short-period comets derives the formulae:

$$m\,(a/\rho_0)^3 > 3 + 5\,e^2$$
$$\rho_1/\rho_2 = \{[(1-e)/(1+e)]\ [1 + m_j\,(r/\Delta)^3]\}^{2/3}$$

The first formula refers to the stability of the comet under the influence of the sun. Here m is the mass of the comet in terms of the mass of the sun, ρ_0 is the radius of the comet's nucleus. In the second formula ρ_1 and ρ_2 are the radii of the sphere of stability under the influence of the sun in perihelion and combined influence of the sun and Jupiter at aphelion, m_j is the mass of Jupiter, r is the heliocentric distance, and Δ is the jovicentric distance of the comet. The rest of the letters denote standard quantities in the theory of orbits. The ratio ρ_1/ρ_2 must be less than unity in order to assure the stability of the comet near aphelion.

Nothing is known about the diameter of the comet's nucleus, except that it must be very small. In 1918 both Van Biesbroeck and Barnard at the geocentric distance nearly unity observed it as stellar in the 40-inch telescope. This may mean 1″ in diameter, but that still is some 700 km in linear measure. As the apparent dimensions of the cometary nuclei are usually grossly exaggerated, we may put its radius at 100 km at maximum. In that case the mass of the comet cannot be less than 7.5×10^{-20} the mass of the sun, or 2.5×10^{-14} the mass of the earth. This result is quite acceptable.

In the second formula, the mass and size of the nucleus do not enter at all so long as the nucleus consists of a number of small bodies. The ratio r/Δ is the most important factor, and with a close approach to Jupiter in aphelion the comet must disintegrate. Callandreau himself found that this must be the case for short-period comets when Δ becomes as small as 0.3 A.U.

Comet Wolf I approached Jupiter within 0.118 A.U. on June 8, 1875, and 0.125 A.U. on September 27, 1922. The above formula (based on the elements for 1918) gives the ratio ρ_1/ρ_2 considerably in excess of unity, namely 2.7. There was no sign of the disruption

of the comet at its discovery in 1883. Also, after the other approach in 1922 the comet was observed in 1925, and there is no evidence at all of any change in brightness. The comet apparently was not affected by its passage in the vicinity of Jupiter.

If Calladreau's reasoning is correct at all, we must seek the explanation of the stability of the comet in some properties that are contrary to his assumptions. The only possible difference in the argument is that the nucleus after all may be a solid body of the nature of a minor planet. Even this improbable hypothesis is not tenable, as in 1884 the nucleus was described as composite by three observers[26] and in 1891 by one.[27]

Without going through Callandreau's involved arguments it is easy to visualize the situation in 1922. The comet approached Jupiter within 0.125 A.U. The cube of the ratio r/Δ happens to be almost exactly 2,000. Since the tidal force is inversely proportional to the cube of the distance, and the mass of Jupiter is about one-thousandth of the mass of the sun, it follows that the tidal force exerted by Jupiter at that approach was twice as great as the tidal force exerted by the sun at perihelion. If the radius of the nucleus was 100 km this would require a mass 1.5×10^{-19} ⊙ in the case of the action of the sun alone, and 3×10^{-15} ⊙ in the case of Jupiter alone, in order that the comet in either case may survive. This is almost the same mass as found by the first formula of Callandreau.

At aphelion, when the comet approached Jupiter, the tidal force of Jupiter exceeded that of the sun by the factor $2\,[(1+e)/(1-e)]^3$ or 106 times. Whether under the combined influence of the sun and Jupiter the comet should disintegrate or not is impossible to answer without very far-reaching assumptions as to the structure of its nucleus. Callendreau maintained that it should, but the comet certainly did not. Nothing happened to its brightness, and its center of gravity did not change. Kamiensky found it possible to combine the motion of the comet before and after 1922, of course with due allowance for the perturbations produce by Jupiter. These, however, affect the comet as a whole without any differentiation between the components of its nucleus.

The figure given for the mass of the comet depends entirely on the assumed radius of its nucleus. With the assumed radius of 100 km, the mass must be at least 10^{-15} of the mass of the earth in order not to disintegrate under the influence of the sun alone. If it were a single solid body of such mass and of the same average density as the earth, then its diameter would be obviously 10^{-5} of that of the earth or only 130 meters. This is of the same order of magnitude as found by Baldet[28] for the Peridodic Comets Pons-Winnecke (1927 VII) and Schwassmann-Wachman 2 (1930 IV). Undoubtedly, the nucleus of Wolf I is extremely small, as in the case of other periodic comets, and what was observed as the nucleus was in reality a dense gaseous en-

velope around it. The smaller the nucleus for the same mass, the more stable it would be, but it is obviously impossible to come to any definite conclusions on this score.

There is another way to show that the visible nucleus was very small. We can use the formula suggested by Baldet,

$$\log \rho = 5 \cdot 83 - 0.2\,\mathrm{h} + \log \mathrm{r} + \log \Delta - 0.5 \log \mathrm{A},$$

where ρ is the radius of the nucleus in meters, h is its apparent stellar magnitude, and A is the average albedo. The nucleus at the time of opposition in 1918 was, according to Van Biesbroeck, about 15^m. It is at once evident that the reflecting surface of the nucleus could not have been that of a single solid body 100 km in radius. Minor planets of this size are very much brighter at greater distances both from the earth and the sun. The formula with a low albedo of 0.1 gives for the radius of the nucleus only 4.4 km.

Baldet's formula can be easily derived from general considerations but it refers to the reflection in the direction of the observer of all the incident light of the sun, or, rather, a certain percentage of it fixed by the value of A. There is no point in refining this formula as the estimates of the stellar magnitude of the nucleus, the most important datum, may be grossly in error, the real nucleus being much fainter. It suffices, however, to show that the diameter of the apparent nucleus is of the order of several kilometers, and certainly not as much as 100 km.

In order not to introduce complicated formulae for the diffusion of light by solid bodies, we may compare the nucleus directly with the moon, assuming that the reflective properties of the two bodies are the same. If the full moon were removed to the distance of the comet, its stellar magnitude would be 1.95, that is $13^m.05$ brighter than the nucleus. The ratio of the radii of the two bodies is at once found to be 408. This means the radius of the nucleus is 4.3 km, that is, almost identical with the one found above.

The peculiarity of the mean daily motion of Comet Wolf I is its decrease amounting to $4''.2 \times 10^{-7}$ per day. Whether this secular decrease has anything to do with the physical properties of the nucleus is hard to say. As is well known a similar irregularity exists in the motion of Encke's Comet, but with the reverse sign. The allowance for the radiation pressure on the particles in the nucleus of Encke's Comet is not sufficient to explain the observed effects.[29] It is, however, becoming increasingly clear that perhaps all comets, if sufficiently well observed, show departures from the motion according to the Newtonian law of gravitation. The retardation in the mean daily motion was found by Recht[30] for the short-period Comet d'Arrest, and the prediction for the return of Halley's Comet[31] in 1910 was wrong by the amount much exceeding the possible uncertainty of calculation. Even

non-periodic comets show sometimes such effects,[32] but unfortunately the computers of definite orbits stop at this point, and do not try to analyse their residuals. Of course a thorough investigation of this problem might reveal a simple explanation, such as the systematic error in the position of the stars, and remove the necessity of considering the physical status of the comets.

Kamiensky derives two more interesting items of information from his study of Comet Wolf I. First, Vsessviatsky's hypothesis of the ejection of periodic comets from Jupiter, improbable on other grounds, is definitely disproved by this comet. Between 1800 and 1942 the comet was never nearer than 0.118 A.U. from Jupiter, whereas its age was given by Vsessviatsky as 120 years. Secondly, the statements of Schulhof and Coniel that Comets Wolf I and 1892 V (Barnard) are pieces of the same body which divided in 1815 when it was near Jupiter are absolutely wrong. These statements were based on the application of the Tisserand criterion without an attempt to trace the motion of both comets to the time when the alleged separation took place.

Comet Wolf I has the curious distinction of being the only comet discovered spectroscopically. It had been discovered by Wolf on September 17, but before the announcement of its discovery reached Dun Echt, Copeland[33] identified it by means of its spectrum. Its spectrum was observed only in the apparition of 1884 by Perrotin[34] and Tacchini[35] besides Copeland, and was found to be largely continuous with the three usual Swan bands.

To sum up the evidence in regard to disintegration of this comet: the absolute brightness of the comet remained the same between 1884 and 1925 and was about $10^{m}.8$ on Barnard's scale. In order to compare this brightness with other comets we must make a rather uncertain allowance for the systematic underestimate of the brightness in very large telescopes. For instance, to reduce this brightness to the photometric system used by me for other comets, a correction not less than $-3^{m}.2$ should be applied. This would make the absolute magnitude of the comet 7.6, as compared with 5.6 for Halley's Comet in the same system.

The whole evidence for the diminution of brightness comes from the two photographic observations of 1934 and one in 1942 which cannot be combined with the visual observations of the preceding years. The general impression is of a drop in brightness between 1925 and 1934 of two or three magnitudes. This would correspond to the difference between the total brightness and the brightness of the nucleus as found by Van Biesbroeck in 1918. It would seem that the round atmosphere about the comet disappeared by 1934, although the short V-shaped tail characteristic of many faint comets still remained in 1942 of much the same aspect as in 1884.

The perturbations in 1922 were almost the reverse of those in 1875,

and the comet was removed to the same regions of inter-planetary space where it was before 1875. If the comet really disintegrated at the rate found by Vsessviatsky, it should have been brighter by several magnitudes before 1884 and should have been easily discovered.

It is therefore inadvisable to talk about the disintegration of short-period comets. The problem is rather of the diminution in the rate of liberation of gases from their nuclei, which may be very sensitive to changes in the average heliocentric distance. If Comet Wolf I were seen under the same conditions as in 1884 its brightness in all probability would be the same. The experience with the variable Comet Schwassman-Wachmann I (1925 II) shows in itself that we should not attach too much cosmological significance to the fluctuation in the brightness of some comets.

References

[1] The notation Wolf I suggests that there is at least one other short-period comet discovered by Wolf. Wolf II is presumably Comet 1924 *d*, but it was observed only at one apparition. It is usually denoted as 1924 V, although its perihelion was passed in 1925. Wolf had his share of bad luck with comets. His short-period comet, 1908 *a*, was shown to be nothing but (516) Amherstia (Zweck, *A. N.*, **208**, 345, 1919). For a while this was considered as a comet in some connection with Encke's (Backlund, *A. N.*, **184**, 313, 1910). Wolf's observation of that famous comet near aphelion in 1916 was again shown to be that of (883) Matterania. On the other hand, Wolf reported the discovery of his *bona fide* comet 1918 III as that of an asteroid 1916 ZK. (*A. N.*, **202**, 303, 1916). This record of a first-class observer shows sufficiently well that it is sometimes not easy to distinguish between a faint comet and an asteroid.

[2] *A. N.*, **117**, 65, 1887.

[3] Kamienski's researches have been printed mostly in the Publications and Reprints of the Warsaw University Observatory. Some earlier work was printed in Russian and even in Japanese publications. Kamienski in a recent article (*M. N.*, **106**, 267, 1947) describes the present status of his work. From this article we learn with regret that much of his recent work was lost in Warsaw during the war.

[4] *Untersuchungen*, etc., *Denkschr. Ak. Wien. Nat.-Wiss. Kl.*, **94**, 1917.

[5] *A. J.*, **32**, 146, 1920.

[6] *A. J.*, **32**, 92, 1920.

[7] C. E. Peek, Rousdon Astr. Obs., 1882-5, p. 14.

[8] *Ann. St. Wien*, **8**, 96, 1892.

[9] *Perkins Obs. Contr.*, Nos. 15, 16, and 19. *P. A.*, **49**, 467, 1941; **50**, 473, 1942.

[10] *Ann. Obs. Belg.*, **14**, 295, 1920.

[11] *A. J.*, **32**, 52, 1919.

[12] *A. N.*, **209**, 61, 1919.

[13] *Observatory*, **41**, 384, 1918.

[14] *A. J.*, **36**, 42, 1926.

[15] *A. N.*, **273**, 63, 1942.

[16] *A. N.*, **228**, 325, 1926.

[17] *A. N.*, **207**, 117, 1918.

[18] *A. N.*, **207**, 118, 1918.

[19] *A. J.*, **41**, 158, 1932.

[20] *A. J.*, **36**, 165, 1926.

[21] *Lick Obs. Bull.*, **17**, 6, 123, 1935.

[22] *Ann. St. Wien.*, **8**, 154, 1892.

[23] *Perkins Obs. Contr.*, No. 15, 1941.

[24] *Lick Obs. Bull.*, **17**, 6, 1936; *Publ. A. S. Pac.*, **46**, 110, 1934.

[25] *Ann. Obs. Paris*, Mem. **23**, D, 1902. These investigations as well as similar ones by Routh, Picart, Darwin, and others are criticized in an article by N. F. Rein, *Publ. Sternberg Astr. Ins.*, **9**, pt. 1, 191, 1936. It is pointed out that

the convergence of power series used by all investigators has not been proved. However, the main term in the second expression is nothing but the ratio of the differential attractions on a particle by Jupiter and the nucleus on the one hand, and by nucleus and the sun on the other. The power series is necessary only for a general treatment of the problem.

[26] Brooks (*Sid. Mess.*, **3**, 318, 1884), Engelhardt (*A. N.*, **109**, 387, 1884), Ingall (*E. M.*, **40**, 1884).

[27] Bigourdan, *Ann. Obs. Paris, Obs.*, 1892, C2.

[28] *Bull. S. A. France*, **44**, 433, 1930.

[29] For the latest investigations of this problem see H. P. Robertson, "Dynamical Effects of Radiation in the Solar System," *M. N.*, **97**, 423, 1937.

[30] *A. J.*, **48**, 65, 1939.

[31] Cowell and Crommelin, *M. N.*, **71**, 320, 1911; Richardson, *Publ. A. S. Pac.*, **54**, 19, 1942.

[32] See for instance definitive orbits of Comet 1905 III by Szeligowski and Koebke (*Acta Astr.*, **3a**, 57, 1934) or of 1911 II by Hahr (*Astr. Takt. Stockholm*, **10**, No. 10, 1921).

[33] *A. N.*, **110**, 9, 1885.

[34] *Ann. Obs. Nice*, **2**, C12, 1887.

[35] *A. N.*, **110**, 11, 1885.

PERKINS OBSERVATORY, DELAWARE, OHIO, DECEMBER 11, 1947.

The Chicago Meeting of the Section on Astronomy of the A.A.A.S.*

By C. C. WYLIE, Secretary

The Section on Astronomy (D) met on the afternoon of Friday, December 26, on the forenoon of Saturday, December 27, and jointly with Section E, Geology, on the afternoon of Saturday, December 27. The joint meeting was a symposium on the origin of the earth.

The papers presented may be grouped as follows: The Address of the Retiring Vice President, Miscellaneous Papers, Meteors and Meteorites, and On the Origin of the Earth. They will be summarized in that order, rather than in order of presentation.

The Address of the Retiring Vice President. G. Van Biesbroeck reported that his work on the eclipse of May 20, 1947, gave for the Einstein deflection 2".00, a value some 15% larger than that calculated. This is in good agreement with earlier observations, but he considered all observed results to date somewhat uncertain. The eclipse of June 20, 1955, will be much better than any on which observations have been made to date.

Miscellaneous Papers. C. H. Smiley reported that photometric measures of light reflected from clouds had given, for two eclipses, good results for times of contacts. Astronomers can get these times of contacts even if a cloud covers the sun.

C. C. Wylie commented on the hysteria produced by unexplained reports of strange objects in the sky. Meteor workers have usually been able to obtain, at little expense, the facts back of these reports. A

*Essentially the same report as this appears in *Science* for February 13, 1948.

nation-wide and year-round investigation of such reports by meteor workers, was suggested as an inexpensive and practical way to eliminate the hysteria.

D. H. Menzel and W. W. Salisbury proposed that cosmic rays are produced by solar radiation of very long wave length, 200 to 2,000,000 miles, which accelerates interplanetary ions.

O. C. Collins recommended that a navigator obtain a "fix" by observing two stars at the same altitude, or at the same azimuth.

W. A. Hiltner reported that the calcium lines in RS Canum Venaticorum appear to come from huge prominences restricted to a small area on the large star.

W. P. Bidelman reported that the spectrum of Rho Cassiopeiae has changed remarkably, and is now similar to that of a very luminous K-type star.

G. Kuiper reported on infrared observations of the planets, and in particular on the finding of carbon dioxide in the atmosphere of Mars.

Meteors and Meteorites. P. M. Millman reported that the spectra of the Giacobinid meteors show important differences from the spectra of the Perseids, which can be attributed to the lower velocity of the Giacobinids.

C. C. Wylie reported that the orbits of three meteors from which meteorites have been recovered are of the asteroid type. These, and similar orbits for other detonating meteors, suggest that meteorites are fragments from the hypothetical planet whose disruption produced the asteroids.

Carl A. Bauer stated that the extreme differences found for the age of meteorites had caused astronomers to doubt their common origin in this hypothetical planet. But, he pointed out, cosmic radiation produces "extra" helium, especially in the smaller meteorites, and this has led scientists to believe them older than they really are.

Harrison S. Brown showed that, if the elements in meteorites represent equilibrium distributions, the meteorites presumably had their origin in a planet similar to the earth or to Mars. He constructed a model of this ancient planet.

On the Origin of the Earth. Kirtley F. Mather stated that presumably the astronomer should have the task of developing a theory to account for the origin of the earth, but the geologist should give the specifications for a newborn earth that would evolve into the earth as it is today. He sketched the stratiform structure of the earth's interior.

James B. Macelwane described the seismological methods of arriving at the structure of the earth's interior, and gave the results rather fully.

Harrison S. Brown, in the paper previously mentioned, showed the

structure of the earth's interior, and, by correcting for the pressure differences, showed that Mars must be strikingly similar. The $1000 prize for "a notable contribution to science" was awarded to Dr. Brown for this as the outstanding paper presented at this meeting of the American Association for the Advancement of Science.

W. J. Luyten (paper read by title in his absence) outlined the Nebular Hypothesis of Laplace, the Planetesimal Hypothesis of Chamberlin and Moulton, and more briefly certain more modern theories. There are seemingly fatal objections to all theories presented to date.

J. Allen Hynek (paper read by D. B. McLaughlin) outlined the Wiezsacker theory, which predicts the spacing of the planets according to Bode's law.

D. ter Haar showed that for the formation of the earth from gaseous material, the temperature must have been between 400° K. and 1000° K.; but the molten earth might have attained much higher temperatures, while liquifying, from energy released during condensation.

Fred L. Whipple outlined a newly-developed theory by which the planets developed in a large cloud of interstellar gas and dust, as it collapsed to form the sun. The planets began as condensations in a smaller cloud of the assembly, and spiralled inward.

Presiding Officers and Attendance. For the Friday afternoon and Saturday forenoon sessions of the Section on Astronomy, D. B. McLaughlin, Chairman of the Section, presided. For the Saturday afternoon joint session with Section E (Geology), which was a symposium on the origin of the earth, F. R. Moulton presided.

The attendance at the Friday afternoon and Saturday forenoon sessions was the seating capacity of the room, or about 40. The attendance at the Saturday afternoon joint session was estimated as 150, about 100 seated and some 50 standing, with scores having been turned away.

University of Iowa, January 28, 1948.

The Annular Eclipse of May 8-9, 1948

The National Geographic Society, Washington, D. C., is laying plans for very extensive observations of this eclipse, primarily to determine the shape and size of the earth with greater accuracy than ever before, as an aid to making better maps.

An unusual circumstance of this eclipse is that it will begin in Burma on May 9 and end in the Aleutians on May 8. The seeming paradox is completely resolved by the crossing of the International Date Line in mid-Pacific.

Associated with the National Geographic Society in this project will be the United States Army's Map Service, Engineers and Signal Corps, the Navy, Air Force, Bureau of Standards, Coast and Geodetic Survey, and the State Department.

Observing stations for the eclipse will be located at the following points: Mergui, Tenasserim Province, southern Burma; Bangkok, Siam; Wu-k'ang, a town about 27 miles from Hangchow, China, on the road to Nanking; Cho-nan, a town about 70 miles south of Seoul, Korea; Rebun Jima, a small island off the northwest coast of Hokkaido, northernmost of the four main islands of Japan; the islands of Adak and Kiska in the Aleutians.

Since there is considerable risk of clouds interfering with observations in the Aleutians, two B-29's of the 311th Reconnaissance Wing, U. S. Air Force, will stand by on Amchitka and Tanaga Islands, prepared to photograph the eclipse from above the clouds. Positions of the planes in the air can be determined very accurately with the aid of Shoran (Short Range Navigation), a device which sends radar signals from the plane to ground stations and receives radar signals back in reply. The interval between departure of the first signal and arrival of the return signal shows very precisely the distance between the plane and the ground station.

Leaders of the observing parties will be: Mergui, Burma, Mr. E. A. Halbach, a director of the Milwaukee Astronomical Society, Wisconsin; Bangkok, Siam, Prof. Charles H. Smiley, director of Ladd Observatory, Brown University, Providence, R. I., assisted by Prof. C. W. Miller of the Brown Physics Department; Wu-k'ang, China, Rev. Francis J. Heyden, S. J., director of Georgetown College Observatory, Washington, D. C., assisted by Dr. Y. C. Chang, a Chinese government astronomer; Cho-nan, Korea, Dr. George Van Biesbroeck, Yerkes Observatory, Williams Bay, Wisconsin; Rebun Jima, Japan, a Japanese scientist to be designated by Prof. Hagihara, director of the Tokyo Astronomical Observatory; Kiska and Adak, Lieutenant Commander Clarence R. Reed and Mr. Clarence A. Shelton, both of the U. S. Coast and Geodetic Survey.

Two of the scientists, Dr. Van Biesbroeck and Father Heyden, were members of the National Geographic Society—U. S. Air Force Expedition which observed the total solar eclipse of May 20, 1947, in Brazil.

Assignment of a Japanese observer to supervise the Japanese observing station represents one of the first occasions since the end of World War II when a Japanese scientist has cooperated with Americans on a research project.

The American observers are expected to assemble and train between now and March 15, and will reach their eclipse stations about April 1.

The Air Transport Command of the U. S. Air Force will fly the

parties to the air terminal of the U. S. military command in each area, and the area command then will get the personnel to the observation sites.

Each party will include, besides an astronomer or geodesist as leader, a radio technician, camera technician, surveyor, cook and camp helper. Personnel of the Rebun Jima party all will be Japanese except for the radio technician who may be assigned from the occupation forces.

Between the first "contact" of the eclipse at Mergui and the end of the eclipse observations in the Aleutians, five hours will elapse. Start of the eclipse at the Southern Burma observation post is placed at 6:53 P.M., Eastern Standard Time on May 8. The end of the final phase at Adak will be approximately 11:53 P.M. (E.S.T.).

All eclipse data obtained at the various stations are to be carefully compared and coordinated for final analysis. With the observation sites so carefully linked and with new techniques employed to double check against error, scientists hope for maximum success.

The mathematical formulas involved in extracting vital information from the eclipse are intricate. The objective, however, is simple. It is to measure with high accuracy not only the precise distance between two given points on the earth's surface, but also to locate the exact position of those points on the globe.

Past efforts of scientists to determine the earth's size and shape have produced results which fall short of the desired accuracy. If their data were used, the relative location of many points on the surface of the earth would be erroneously fixed at anywhere from several hundred feet to as much as a mile from their true position.

Given a reasonable break on the weather along the 5,320-mile arc of stations, observations of the May eclipse are expected to yield information which will enable relative positions on the earth's surface to be pin-pointed within 150 feet or less, a negligible error on the vast reaches of the globe. Such a result would be an enormous boon to highly accurate mapmaking, as well as a first class scientific achievement.

Leading thinkers, scholars, and scientists have been seeking to determine the correct size and shape of the earth ever since the days of the Greek philosopher, Pythagoras, who expounded his theories on the earth as a sphere about 550 B. C. Noted names have followed him through the centuries. Eratosthenes of Alexandria, Egypt, (276-195 B. C.) was the first known writer to describe and apply a method for using the sun as a measuring tool to get more information on the earth's size and shape. The Arabian Caliph Al Mamun of the ninth century, A. D.; the Europeans, Delambre, Bessel and Clarke of the 19th century; and the American John F. Hayford, of the Coast and Geodetic Survey, early in the 1900's, all contributed to advancing the fund of knowledge on the subject, but their experiments and research failed to achieve results of satisfactory accuracy.

The findings Hayford produced from his computations are generally conceded to be the most precise yet obtained in the 2,500-year quest. Scientists are looking to the May eclipse to yield information which will bridge, wholly or in part, the gap between Hayford and the goal of workable accuracy.

The above information has been taken from news bulletins issued by the National Geographic Society.

The Planets in April, 1948

By RAYMOND H. WILSON, JR.

NOTE: The time employed is Central Standard Time unless otherwise indicated. The phenomena have been chosen and described for the North American continent, and especially for the United States. The basic data have been taken principally from the *American Ephemeris and Nautical Almanac*.

Sun. At the end of this month the sun will be 15 degrees north of the equator. In declination and, therefore, in the effective delivery of light and heat, the sun's position during this month corresponds to that in August. However, the dissimilarity of ground temperatures in these two months, especially in the north, makes this fact hard to realize.

Moon. The phases of the moon will occur as follows:

Last Quarter	April	1	4 A.M.
New Moon		9	7 A.M.
First Quarter		16	2 P.M.
Full Moon		23	7 A.M.
Last Quarter		30	11 P.M.

The moon will be nearest to the earth on April 19.

No bright stars will be occulted during the month.

On April 23 at 5:20 A.M., Pacific Standard Time, the moon will enter a partial eclipse. This will be invisible in the United States except perhaps for five or ten minutes just before a clear moonset on the coast of northern California.

Evening and Morning Stars. Venus, Saturn, and Mars will be conspicuous evening stars, while Jupiter will be visible in the southeastern sky after midnight.

Mercury. This planet might be seen just before sunrise during the first part of the month. On the morning of April 7 it will be 5 degrees east of the waning moon.

Venus. On April 14 this brilliant planet will reach a maximum distance of 46 degrees east of the sun. In addition, its declination will be more than 25 degrees north, making for an extraordinarily high altitude at sunset for northern observers.

Mars. The red planet will be most favorably situated this month for early evening observation. It will have begun again its direct eastward motion.

Jupiter. This planet will appear brilliant but at low altitude after midnight in the constellation Sagittarius.

Saturn. This planet with its rings will be 3 or 4 degrees southwest of Mars in Leo, and, like Mars, will be in a position most favorable for early evening observation.

Uranus. Uranus will be moving slowly northeastward on the ecliptic, 3 degrees northwest of ζ Tauri.

Neptune. Neptune will be moving slowly northwestward at a position 2 degrees directly south of γ Virginis.

Department of Mathematics, Temple University, Philadelphia, Pa.
February 2, 1948.

Occultations for April, 1948

(Taken from the *Amerian Ephemeris*)

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

				IMMERSION				EMERSION			
Date 1948	Star		Mag.	Greenwich C.T.	*a*	*b*	Angle E from N	Greenwich C.T.	*a*	*b*	Angle E from N
				h m	m	m	°	h m	m	m	°
Occultations Visible in Longitude +72° 30′, Latitude +42° 30′											
Apr.	16	47 Gemi	5.6	0 3.8	−1.9	+0.1	71	1 7.7	−0.7	−2.5	313
	17	λ Canc	5.9	3 37.7	−0.1	−2.2	137	4 30.7	−0.4	−1.2	265
	17	90 H.³Canc	6.1	23 21.6	−1.8	−0.1	103	0 38.3	−1.5	−1.5	306
	19	42 Leon	6.1	5 41.2	−1.1	−0.9	68	6 16.9	+0.5	−2.5	352
	21	*b* Virg	5.2	0 4.2	−0.8	−0.8	143	1 11.6	−1.6	+0.1	288
	21	10 Virg	6.1	6 32.4	−0.7	−1.9	130	7 34.2	−0.4	−1.7	296
Occultations Visible in Longitude +91° 0′, Latitude +40° 0′											
Apr.	15	47 Gemi	5.6	23 27.1	−2.0	−0.1	93	0 49.3	−1.8	−1.1	284
	16	134 B.Gemi	6.5	2 35.5	−1.6	−0.5	76	3 35.2	−0.2	−2.3	313
	17	90 H.³Canc	6.1	22 51.4	−1.5	−0.2	119	0 7.5	−1.9	+0.2	280
	19	42 Leon	6.1	5 23.1	−1.2	−1.4	104	6 24.2	−0.3	−2.1	321
	20	*b* Virg	5.2	23 57.5	−0.3	−2.2	171	0 39.1	−1.5	+2.5	252
	21	10 Virg	6.1	6 24.3	−0.6	−2.2	158	7 23.3	−1.3	−1.3	275
Occultations Visible in Longitude +98° 0′, Latitude +30° 0′											
Apr.	15	47 Gemi	5.6	23 20.8	−2.5	−2.1	132	0 33.0	−2.8	+1.6	240
	16	BD+27°1337	6.4	0 21.2	..	..	34	0 57.8	..	..	345
	16	134 B.Gemi	6.5	2 36.5	−1.3	−1.7	116	3 48.0	−1.0	−1.1	275
	19	42 Leon	6.1	5 32.8	−0.9	−2.1	137	6 38.9	−0.8	−1.5	293
Occultations Visible in Longitude +120° 0′, Latitude +36° 0′											
Apr.	16	134 B.Gemi	6.5	1 48.6	−2.0	−1.5	119	3 7.6	−2.1	−0.2	261
	19	42 Leon	6.1	5 1.4	−0.5	−3.1	168	5 57.8	−2.4	−0.3	263
	22	θ Virg	4.4	11 5.8	−1.9	+1.1	48	11 24.9	+0.1	−4.5	13
	27	163 G.Ophi	6.4	11 35.7	−2.2	−1.2	132	12 49.3	−1.9	+0.2	239

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

Many observations were made by some of our members, and by others who send us their reports, during the parts of October and December when the Orionids and Geminids are expected. We also have fewer reports covering the dates when Giacobinids or the Draconids, connected with Giacobini-Zinner's Comet, might have appeared, and for the dates in November covering the Leonid epoch.

Briefly, because the main condensations of the Leonids are near aphelion, as expected, very few Leonids were seen. The Giacobinids showed at most a few stragglers as has been their habit in the years between their brief but brilliant appearances. The Orionids were poor in 1947, and the main stream less clearly differentiated from its minor branches. The Geminids, however, showed up excellently. In fact, they vie with the Perseids for first place among the annual showers. They are far less observed because they appear in cold weather, and most people will not brave the temperatures of a mid-December night. In 1947, however, a good many did and they were well rewarded.

In the first table will be found the data, now at hand (more will probably come in from members who do not report on time) which would aid in computing hourly rates for the nights in question. It is divided into three parts: the first contains reports from those who plotted and (or) described each meteor, the second, reports from those who generally counted only, the third, reports which arrived later. All rates are uncorrected. In the second table, which contains more radiants derived from plotting done in 1947, the notes will indicate those which I consider refer to the various showers. Only in the case of the Orionids can, I believe, there be differences of opinion. Indeed, often it takes very good plotting to indicate without a doubt whether a meteor belongs to the main Orionid radiant or to one of the number of contemporary minor streams which are known to exist in that region of the sky. More time and thought than usual were given to working out these radiants but even then some mistakes of judgment have doubtless been made. The numbers given in the 'Notes' column refer to A.M.S. radiants which appear to confirm same in this list.

As our maps and blanks had begun to run low, a fresh supply of both have been ordered. The blanks have already been printed and are on hand, the maps should be in about a month. If any of our active members have not received all they need of either, they will understand the reason. As soon as the reprint containing the Meteor Notes for 1947 is received, that and Reprint No. 69 dealing with long-enduring meteor trains which is already here, along with Graphic Time Table of the Heavens kindly furnished by the Maryland Academy of Sciences, will all be mailed to members who have paid their dues for 1948. Many have already done so; the rest are urged to send in their dues without waiting to be billed for them, which involves time, trouble, and needless expense.

The A.M.S. starts out 1948 with more active members than for a long time and, as conditions are somewhat more peaceful, it is hoped that an excellent record may be made. Particular attention should be paid to the Lyrids from

about April 19 to 23 and even more to the Eta Aquarids which come during the first week of May. All members are urged to be more ready to report or collect reports of brilliant fireballs seen in their states. This is something which rarely occurs for an individual and the time and trouble necessary are well repaid. Even the most inactive member could do this much for the good of the Society.

Station, Observer and Time	Date 1947	Began	Ended	Min.	Met.	F	Rate	C
Alabama								
Nauvoo—C.S.T.								
Scott, T.	Oct. 6	7:55	10:25	150	27	1.0	11	P
" "	8	9:15	11:45	150	29	1.0	12	P
" "	9	6:50	11:00	240	42	1.0	10	P
" "	12	9:20	11:30	130	15	1.0	7	P
" "	17	8:15	10:45	150	17	0.9	7	P
" "	20	9:10	12:30	200	21	1.0	6	P
" "	21	12:00	14:30	150	31	1.0	12	P
" "	23	12:05	13:45	100	21	1.0	13	P
" "	Nov. 15	12:35	14:50	135	28	0.9	12	P
" "	Dec. 5	8:30	11:00	150	20	0.9	8	P
" "	13	7:15	8:20	60	15	0.7	15	P
Wyoming								
Laramie—M.S.T.								
Beetle, Mrs. D. E.	Oct. 17	13:15	14:15	60	9	1.0	9	P
" "	19	14:48	17:07	139	24	0.9	10	P
New York								
Spring Valley—E.S.T.								
Burns, H. A.	Oct. 20	11:55	15:13	198	33	1.0	10	P
" "	22	14:18	16:18	120	30	1.0	15	P
" "	23	14:28	17:00	152	20	0.6	8	P
Maine								
Cape Elizabeth—E.S.T.								
Dole, R. M.	Oct. 8	8:30	11:30	...	0	1.0	0	..
" "	9	8:30	11:00	...	0	1.0	0	..
" "	19	15:00	16:00	...	0	0.8	0	..
" "	20	12:30	14:45	135	25	1.0	11	P
" "	Nov. 15	13:00	15:00	...	0	...	0	..
" "	16	13:00	15:00	...	0	...	0	..
" "	Dec. 11	9:00	11:00	120	5	1.0	2	..
" "	13	9:30	14:00	270	116	1.0	26	P
" "	14	9:30	10:00	30	15	1.0	30	P
New Hampshire								
Strafford—E.S.T.								
Dupee, Mrs. D. S.	Oct. 8	12:00	13:00	60	3	1.0	3	P
" "	9	7:15	9:15	120	3	1.0	2	P
" "	18	10:45	11:15	30	1	0.5	2	P
" "	19	13:30	14:30	60	9	1.0	9	P
" "	19	15:15	16:45	90	13	1.0	9	P
" "	Dec. 11			90	2	1.0	1	..
New York								
New York—E.S.T.								
Fein, L.	Dec. 13	8:15	10:45	150	25	0.6	a	P
Iowa								
Sibley—C.S.T.								
Fitzsimmons, C. S.	Oct. 18	13:00	14:30	90	14	1.0	9	P
" "	19	10:13	12:25	132	15	1.0	7	P
" "	20	12:30	14:05	95	14	1.0	9	P

Station, Observer and Time	Date 1947	Began	Ended	Min.	Met.	F	Rate	C
California								
Fall Brook—P.S.T.								
Forsyth, E. L.	Oct. 8	8:	11:	...	1	?	..	D
" "	9	6:	9:	...	0	0.2	..	..
" "	12	6:	7:45	...	2	0.8	2	D
" "	18	14:10	16:30	140	12	1.0	5	D
" "	19	12:30	14:40	?	6	0.4	..	D
" "	21	13:20	14:15	55	10	1.0	11	D
Delaware								
Wilmington—E.S.T.								
Hukill, R. M.	Oct. 18	14:00	15:20	80	8	0.6	6	P
" "	19	14:00	15:20	80	16	1.0	12	P
Maryland								
Blossom Point—E.S.T.								
Johnson, L. T.	Oct. 22	11:02	13:31	149	18	0.7	7	P
Connecticut								
New Britain—E.S.T.								
Posten, H.	Dec. 12	12:20	13:45	64	21	0.9	20	P
Illinois								
Batavia—C.S.T.								
Siekman, Wm.	Oct. 18	13:00	16:00	165	35	0.7	13	P
" "	21	15:00	16:00	60	18	0.7	18	P
" "	Nov. 22	14:00	15:00	60	8	0.4	8	P
" "	Dec. 13	11:00	13:55	175	76	0.6	23	P
Maine								
Seal Harbor—E.S.T.								
Turnbull, H. S.	Oct. 9	6:45	7:20	35	4	1.0	7	P
" "	Nov. 21	7:20	8:05	45	2	0.5	3	P
" "	Dec. 11	7:55	8:30	35	4	1.0	7	P
Louisiana								
Baton Rouge—C.S.T.								
Weinstein, B.	Oct. 23	10:	12:	120	4	...	2	D
New York								
Bronx—E.S.T.								
Weitzenhoffer, K.	Oct. 19	14:00	16:00	120	8	0.7	4	P
" "	20	14:15	16:15	120	17	1.0	8	P
" "	21	14:00	15:00	60	5	1.0	5	P
Indiana								
Plevna—C.S.T.								
Wright, M. G.	Oct. 22	13:58	14:58	60	20	1.0	20	P
Massachusetts								
Marblehead—E.S.T.								
Knowles, J.	Oct. 17	13:00	16:00	180	30	1.0	10	C
" "	Nov. 14	14:00	16:00	120	21	1.0	10	C
" "	Dec. 12	10:00	12:00	123	35	0.7	17	C
" "	13	13:45	16:00	135	112	1.0	50	C
Nebraska								
Beatrice—C.S.T.								
Mains, M. M.	Oct. 8	11:00	12:00	60	4	...	4	C
" "	9	11:00	12:00	60	3	...	3	C
Illinois								
Batavia—C.S.T.								
Group with W. J. Siekman	Dec. 13							
Peabody, J.		10:40	11:40	60	35	0.8	35	C
" "		12:00	13:55	115	109	0.8	57	C
Bufkin		10:40	11:40	60	42	0.8	42	C
" "		11:55	13:55	120	102	0.8	51	C
Pierce, L. W.		10:58	11:58	60	34	0.8	34	D
" "		12:00	14:00	120	117	0.8	58	C

Station, Observer and Time	Date 1947	Began	Ended	Min.	Met.	F	Rate	C
California								
Coronado—P.S.T.								
von Kleeck, E. Stc.	Dec. 12	10:30	11:05	35	14	1.0	24	C
" "	13	7:20	12:20	...	21	...	..	C
Alabama								
Nauvoo—C.S.T.								
Scott, T.	Oct. 5	7:20	9:20	120	14	1.0	7	P
" "	13	8:10	9:10	60	10	1.0	10	P
" "	Dec. 6	8:05	9:25	80	7	0.7	5	P
Connecticut								
East Haven—E.S.T.								
Anyzeski, V.	Dec. 13	10:54	12:00	66	45	1.0	41	P
Leroy, S.	13	10:54	12:00	66	26	1.0	24	PC
Neale, J. J.	13	10:54	12:00	66	26	1.0	24	PC
Leroy, Mrs. O.	13	10:54	12:00	66	27	...	25	PC
Illinois								
Chicago—C.S.T.								
Anderson, R. F.	Oct. 9	9:00	11:30	150	3	...	1	C
" "	Dec. 12	11:00	13:00	120	6	...	3	C
Hay, A. A.	Oct. 9	9:30	11:00	90	5	0.7	3	P
" "	Dec. 16	9:30	11:45	135	0	0.5	0	..
Iowa								
Des Moines—C.S.T.								
Johnson, M. C.	Oct. 10	10:00	12:00	120	8	1.0	4	D
" "	11	11:30	13:30	120	2	...	1	D
" "	12	9:30	11:30	120	7	0.7	4	D
" "	17	11:00	12:15	75	4	1.0	3	D
" "	18	11:00	12:30	90	2	...	1	D
New York								
New York—E.S.T.								
Oravec, E.	Dec. 12	9:40	11:02	60	5	0.6	5	P
Sky Skanners	12	9:	11:20	140	14	1.0	..	D
Brooklyn								
Waldmann, E. G.	Oct. 23	12:46	13:51	65	9	0.9	8	P
" "	24	12:57	13:57	60	7	0.9	7	P
Bronx								
Korn, H.	Dec. 12	11:45	13:45	120	15	0.7	8	P
Korn, K. W.	12	9:40	13:44	137	17	0.5	7	P
Chabot, H. L.	12	9:00	13:25	180	22	0.6	7	P
Weitzenhoffer, K.	12	10:15	11:00	45	5	0.8	7	D
Oregon								
Portland—P.S.T.								
Widner, R.	Nov. 21	8:00	9:45	105	11	1.0	6	P
" "	Dec. 20	9:40	10:40	60	3	1.0	3	P
Pennsylvania								
Norristown—E.S.T.								
Naylor, C. D.	Oct. 19	11:45	14:45	180	21	1.0	7	P
" "	Nov. 12	14:55	17:00	125	10	1.0	5	P
" "	Dec. 14	9:05	11:05	120	13	1.0	6	P
Texas								
Baytown								
Dzilsky, J.	Dec. 13	9:00	10:10	70	17	1.0	15	C
Rutkowski, E.,								
$\lambda = 175°$ E, $\phi = 25°$ N, Time 24								
	Nov. 10	10:28	11:28	60	22	0.9	22	DP
$\lambda = 170°$ W, $\phi = 23°$ N	12	8:10	11:10	180	37	0.6	12	DP
$\lambda = 166°$ W, $\phi = 22°$ N, Time I								
	13	8:10	10:10	120	26	0.8	13	DP
$\lambda = 162°$, $\phi = 22°$, Time I	14	8:15	10:20	125	21	0.9	10	DP

A.M.S. No.	Date 1947		R.A.	Decl.	Meteors	Accuracy	Observer and Notes
2402	Feb.	28.2	163°	+14°	4	fair	Anyzeski, V.—2 on 27, 2 on 28
2403	April	6.6	187	+58	14	good	Dole, R. M.
2404	May	9.7	221	+16	4	good	Scott, T.
2405		9.7	239.5	−14	4-6	good	Scott, T.
2406		9.7	259	−13	3-4	fair	Scott, T.
2407		21.8	246	+15	5-6	fair	Posten, H.
2408		21.7	265	+ 4	4	f.g.	Scott, T.
2409		27.8	282	+12.5	4	f.g.	Scott, T.
2410		31.8	294	+37	3-5	fair	Hukill
2411		31.8	299	+18	5	f.g.	Hukill
2412	June	9.7	292	+ 8	4	fair	Scott, T.
2413		14.7	217	+58	6	f.g.	Scott, T.
2414		14.7	299	+73	4	good	Scott, T.
2415		17.7	204	+ 8	6	v.g.	Scott, T.
2416		17.7	249	−18	3	good	Scott, T.—2613
2417		17.7	269	− 4.5	4	f.g.	Scott, T.—1017?
2418		17.7	287.5	+11	4—	fair	Scott, T.
2419	July	9.7	298	−26	3	f.g.	Scott, T.
2420		19.7	330	+32	3	good	Scott, T.
2421		21.8	326	+32.5	4	good	Scott, T.—1128
2422		26.8	290	+ 5	4	good	Scott, T.
2423		26.8	341	−13	5-6	fair	Scott, T.—δ Aquarids
2424		28.8	24	+30	4-5	good	Scott, T.
2425		28.8	320	+12	5	fair	Scott, T.—1 on 26 also
2426		28.8	328	−15	4	fair	Scott, T.—3 on 26 also
2427		28.8	342	−16.5	8	good	Scott, T.—δ Aquarids
2428	Sept.	10.7	332	+14.5	4	good	Scott, T.
2429		10.7	355	+ 5.5	4-5	good	Scott, T.
2430		10.7	359.5	+12	4-5	good	Scott, T.
2431		11.7	353	+35	5-6	good	Scott, T.
2432		14.8	30	−29	3	f.g.	Burns, H. A.
2433		14.8	64	+15.5	5-9	good	Burns, H. A.
2434		14.8	88	+ 1.5	5	good	Burns, H. A.—1803
2435		14.8	89	+27.5	5	good	Burns, H. A.
2436		16.7	348	0	5-6	good	Burns, H. A.
2437		20.7	37.5	+41.5	6	good	Scott, T.
2438	Oct.	9.6	9	+52	6	fair	Scott, T.
2439		17.6	21	+19	4	fair	Scott, T.—597
2440		6.63	28	0	4	good	Scott, T.
2441		20.8	44	+ 3.5	4-5	f.g.	Burns, H. A.—1595, 1270
2442		17.6	46	+ 7	3-4	poor	Scott, T.—73, 1560, 371, 73, 83, 101
2443		20.7	52	+19	4-8	f.g.	Scott, T.—84, 692?, 270, 263, 1306
2444		18.8	54	+29.5	6-8	good	Siekman, W.—707
2445		18.8	64	+15	3	good	Siekman, W.—75
2446		20.8	83	+12	3-5	f.g.	Burns, H. A.—confirmatory
2447		22.8	84	+12	5-8	f.g.	Burns, H. A.—confirmatory
2448		21.8	86	+ 8	5-8	good	Scott, T.—confirmatory
2449		20.8	87.5	+ 9	6∓	good	Weitzenhoffer, K.—confirmatory
2450		18.8	88	+ 2	7-8	f.g.	Siekman, W.
2451		23.8	89.5	+12.5	6-8	good	Scott, T.—Orionids
2452		20.8	90	+14	9±	f.g.	Weitzenhoffer, K.—Orionids
2453		23.9	90.5	+13	10	good	Burns, H. A.—Orionids
2454		18.8	91	+17	5	f.g.	Siekman, W.—Orionids
2455		21.8	91	+15	4	poor	Weiteznhoffer, K.—Orionids
2456		22.8	91	+17.5	6-8	f.g.	Burns, H. A.—Orionids
2457		20.8	91.5	+13.5	5-6	f.g.	Burns, H. A.—Orionids
2458		21.8	92	+16	6	good	Scott, T.—Orionids
2459		20	92	+13.7	15	v.g.	Dole, R. M.—Orionids
2460		21.9	92.5	+15	6	good	Siekman, W.—Orionids
2461		19.9	93.4	+17.3	3-6	f.g.	Weitzenhoffer, K.—Orionids

A.M.S. No.	Date 1947	R.A.	Decl.	Meteors	Accuracy	Observer and Notes
2462	Oct. 19.9	97°	+14°	5	poor	Burns, H. A.—confirmatory
2463	21.8	98	+15	5-7	good	Scott, T.—confirmatory
2464	9.6	261	+55	3	good	Scott, T.—Giacobinids
2465	8.7	269	+55	5-6	good	Scott, T.—Giacobinids
2466	8.7	329	+34	4	f.g.	Scott, T.
2467	9.6	343	+44	7-8	good	Scott, T.
2468	Nov. 5.6	39	+48	4	good	Scott, T.
2469	15.8	149.3	+25	6	good	Scott, T.—Leonids
2470	Dec. 5.7	80	+29	3	fair	Scott, T.—418
2471	5.7	89	+35.5	5	good	Scott, T.—758
2472	5.7	94.5	+23.2	4	good	Scott, T.—294
2473	12.8	115	+28	11-14	good	Posten, H.—Geminids
2474	13.6	107.5	+29.5	10	f.g.	Scott, T.—Geminids
2475	11.6	112.7	+32.7	4	v.g.	Dole, R. M.—Geminids
2476	13.7	112.8	+31.5	90	good	Dole, R. M.—Geminids
2477	13.8	113.8	+28.3	10	good	Siekman, W.—Geminids
2478	13.7	113.1	+31.4	10	v.g.	Dole, R. M.—Geminids
2479	13.7	144	+17	6±	fair	Dole, R. M.

Flower Observatory of the University of Pennsylvania, Upper Darby, Pa.
1948 February 2.

Contributions of The Meteoritical Society

(Known Formerly as The Society for Research on Meteorites)

Edited by FREDERICK C. LEONARD

Department of Astronomy, University of California, Los Angeles 24

The Largest Known Meteorites of the World: Supplementary Paper

FREDERICK C. LEONARD
Department of Astronomy, University of California, Los Angeles

ABSTRACT AND INTRODUCTION

This paper, which is a supplement to Miss Alley's and my "Catalog of the Largest Known Meteorites of the World" (*C. M. S.*, **4**, 71-5; *P. A.*, **55**, 497-502, 1947), consists essentially of 2 tables, in which the meteorites are arranged in the order of decreasing weight, as are those in the forenamed catalog. Table 1 gives additional data for some 20 specimens that are included in the catalog, while Table 2 is a supplementary list of 8 great meteorites (of which 5 are Canyon Diablo, Arizona, irons) that were unintentionally omitted from it. The latter table brings to 66 the number of known individual meteorites weighing 400 kilograms or more, of which we have been able to find records. For most of the information contained in the "Name and Remarks" column of Table 1, I am indebted to Mr. Edward P. Henderson, Associate Curator of Mineralogy and Petrology in the United States National Museum, and for much of that in the corresponding column of Table 2, to certain officers of the several museums mentioned in that table.

TABLE 1

FURTHER NOTES ON SOME OF THE WORLD'S LARGEST METEORITES

C.N.†	NAME AND REMARKS
— 179,196	Hoba West: 2489 gm. Brit. Mus. (Nat. Hist.); 1175 gm., U. S. Nat. Mus.
1078,261	Bacubirito: est. wt. 27 tons; 1¾ kg. Chgo. Nat. Hist. Mus.; 1.1 kg. Brit. Mus.
— 331,091	Mbosi: est. wt. 12-15 tons; 430 gm. Brit. Mus.
1057,279	Morito: 714 gm. U. S. Nat. Mus.
1245,428	Port Orford: "There is so little known about this ms., and the historical record of its discovery is open to such grave doubts, that I question whether it is desirable to continue reporting the specimen as 10,000 kg.; 24 gm. in U. S. Nat. Mus." (E. P. Henderson).
± 382,130:*	Bendegó: 5360 kg. fd. (*Phil. Trans. Roy. Soc., London*, **106**, 270, 1816); 3.5 kg. Chgo. Nat. Hist. Mus.; 243 gm. U. S. Nat. Mus.
± 486,262	Santa Catharina: 3.75 kg. Harvard Univ.; 2.8 kg. U. S. Nat. Mus.; 1.5 kg. Am. Mus. Nat. Hist.
—1358,224	Huckitta Station: "mn. ms. weighed 3112 lb. or 1415 kg.; fd. 1937 June, but apparently known by cattlemen for several years bef." (Henderson).
1078,304	Cases Grandes de Malitzin: 1317.9 kg. U. S. Nat. Mus.
∓ 65,500	Bitburg: 1 kg. Chgo. Nat. Hist. Mus.
∓ 204,493	Magura: 1½ kg. Chgo. Nat. Hist. Mus.; 1 kg. Am. Mus. Nat. Hist.
1205,420	Goose Lake: mn. ms., 1169.5 kg. U. S. Nat. Mus.
1025,228	Zacatecas: 1¼ kg. Chgo. Nat. Hist. Mus.
—1178,319	Youndegin: 5.2 kg. U. S. Nat. Mus.; 5 kg. Am. Mus. Nat. Hist.
832,358	Cosby's Creek: 51.3 kg. Brit. Mus.
1010,231	Charcas: 7½ kg. Chgo. Nat. Hist. Mus.
—1513,239	Gladstone: 20.7 kg. U. S. Nat. Mus.; 16 kg. Am. Mus. Nat. Hist.
1109,322	Tucson: 632.2 kg. U. S. Nat. Mus.
∓ 69,436	La Caille: fd. 1600; reg. 1828.
1083,346	Grant: 481.8 kg. U. S. Nat. Mus.; fd. 1929 Jan.; described *N. S. R. M., P. A.*, **42**, 511-15, 1934; new analysis: *Am. Jour. Sci.*, **239**, 408, 1941.

NOTE TO TABLE 1

†For an explanation of the *signs* of the coördinate numbers (C.N.) in this column, *v. C. M. S.*, **4**, 82-4; *P. A.*, **55**, 553-5, 1947.

TABLE 2

THE LARGEST KNOWN METEORITES OF THE WORLD: SUPPLEMENTARY LIST

C.N.	NAME AND REMARKS
819,329	Sardis, Burke-Jenkins Cos., Georgia, U.S.A.: cl. = Og; wt. = 790.9 kg.; fd. 1940; in U. S. Nat. Mus.; *v. Proc. U. S. Nat. Mus.*, **92**, No. 3143, 141-50, 1942, and *C. M. S.*, **4**, 31-2; *P. A.*, **55**, 167-8, 1947.
—1453,381	Cranbourne, Mornington Co., Victoria, Australia, Ser. No. 4: cl. = Og; wt. = 750 kg. (1 ms.); in U. S. Nat. Mus. Members of this fall were fd. first in 1854. The 454-kg. specimen, listed as Ser. No. 4 on the last page of the catalog (referred to in the Abstract & Introduction, *ante*), should now bear Ser. No. 5.
1110,350	Canyon Diablo, Coconino Co., Arizona, U.S.A., Ser. No. 1: cl. = Og; wt. = 639.1 kg. The famous Canyon Diablo fall, which is concentric with the equally famous Barringer Meteorite Crater, and of which this specimen is the largest recovered individual on record, was recognized as being meteoritic in 1891. This specimen, the property of the Barringer family, is on loan to the

Am. Meteorite Mus., on U. S. Highway 66, near "Crater Junction."

1129,395 Drum Mountains, Millard Co., Utah, U.S.A.: cl. = Om; wt. = 529.0 kg. (1 ms.) ;fd. 1944 Sep. 24; in U. S. Nat. Mus.; *v. C. S. R. M.*, **3**, 185; *P. A.*, **53**, 87, 1945.

1110,350 Canyon Diablo, Coconino Co., Arizona, U.S.A., Ser. No. 2: wt. = 493.1 kg.; in Am. Mus. Nat. Hist.; *v.* Ser. No. 1, *ante.*

1110,350 Canyon Diablo, Coconino Co., Arizona, U.S.A., Ser. No. 3: wt. = 460.304 kg.; in Chgo. Nat. Hist. Mus.; *v.* Ser. No. 1, ante.

1110,350 Canyon Diablo, Coconino Co., Arizona, U.S.A., Ser. No. 4: wt. = 459.09 kg.; in U. S. Nat. Mus.; *v.* Ser. No. 1, *ante.*

1110,350 Canyon Diablo, Coconino Co., Arizona, U.S.A., Ser. No. 5: wt. = 452.7 kg.; in U. S. Nat. Mus.; *v.* Ser. No. 1, *ante.*

A Note on "The Lost" Port Orford, Oregon, Pallasite (1245,428)

Referring to the catalogs of Frederick C. Leonard and Dorothy H. Alley in *C. M. S.*, **4**, 58-65, 71-5; *P. A.*, **55**, 381-8, 497-502, Aug. and Nov., 1947, I can add a few words to the data about "the lost" Port Orford, Curry Co., Oregon, pallasite (cl. = PK; C.N. = 1245,428). Aside from the 4 grams in the Vienna Natural History Museum, there are also 25 grams in the United States National Museum, Washington, D. C., according to the following letter, dated 1938 March 12, from Assistant Secretary A. Wetmore of the Smithsonian Institution:

"In response to your inquiries [concerning the Port Orford meteorite], Dr. W. F. Foshag, Curator of Mineralogy and Petrology, makes the following statement:

" 'The U. S. National Museum has 25 grams of the Port Orford meteorite. It is in good condition. The olivine is pale greenish-yellow in color.

" 'Captain Evans did not mention the Sixes River in his journal in connection with the meteorite, but repeatedly referred to it in relation to his route. This followed, in large part, along the divide of Sixes River and Flores Creek.

" 'The Museum has been interested in this meteorite for many years, and much has been done toward locating it. Because of our work there, numerous vague ideas are current in the region, as I found out when I visited the section, but many of these are traceable to our efforts and inquiries, and are not based on actual information. Captain Evans does not place this meteorite on Bald Mountain, but upon a "bald mountain," which, since the advent of the Forest Service, is probably no longer bald.' "

J. Hugh Pruett

The Evergreen Observatory, 1832 Longview Drive, Eugene, Oregon,
1947 December 29

"A Comet Strikes the Earth" (Review)

A second edition of the pamphlet bearing the above title, originally copyrighted in 1942 by H. H. Nininger, has been published (1946) by the Desert Magazine Press, of El Centro, California. The general nature of the booklet is well indicated by Dr. Frederick C. Leonard's review of the first edition (*C. S. R. M.*, **3**, 63; *P. A.*, **50**, 565, 1942). The present review therefore concerns itself solely with the most important modification noted in the second edition, namely, a change in the certification relating to the tiny specimen of oxidized meteoritic material sold with the pamphlet. Surely no publication has profited

more greatly in a scientific way by a single revisional change than has the booklet under review, by this emendation.

In the earlier edition, the certification in question reads: "This is to certify that the accompanying specimen is a genuine meteorite which was collected by the author within 2 miles or less of the crest of the Barringer Crater rim." In the second edition, this certification has been changed to read as follows: "I certify that the attached specimen is an oxidized fragment of nickel-iron meteorite which was collected just outside the rim of Barringer Crater. It was doubtless once a part of the meteorite, or perhaps swarm of meteorites, which thousands of years ago collided with the Earth to form that crater."

Members of the Meteoritical Society, who, at the Ninth Meeting of the Society, at Flagstaff, Arizona, in September, 1946, participated in the debate and Society action on the practice of certifying and selling specimens of meteoritic shale to the general public as genuine meteorites, will welcome the revised certification accompanying such specimens in the booklet under review as additional evidence of the soundness of the majority opinion so emphatically expressed at that meeting.

LINCOLN LA PAZ

Institute of Meteoritics, University of New Mexico, Albuquerque,
1947 December 23

A Correction.—In *C. M. S.* in the January, 1948, issue of *P. A.*, the first 2 lines of the second paragraph beginning on p. 42 should read thus:

"In this device, braces, brackets, and parentheses either represent, or inclose the symbols of, the principal categories of meteorites as enumerated in Table 1, . . ."

President of the Society: ARTHUR S. KING, Mount Wilson Observatory, Pasadena 4, California

Secretary of the Society: OSCAR E. MONNIG, 1010 Morningside Drive, Fort Worth 3, Texas

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VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

Notes on Current Observed Variables: The following remarks are listed after an examination of the plots of currently observed variables on the AAVSO program, and pertain to the observations as made from July, 1946, to date.

0010*32*, S Scl; A well-marked "stillstand" occurred on the increase to maximum between magnitudes 11 and 9, and J.D. 2432450 and 2510.

0024*38*b, RR Scl; Variation, if any, does not exceed a tenth of a magnitude.

003455, α Cas; Not much indication of real or regular variation—considerable scatter between estimates by different observers.

005060, γ Cas; See remark on α Cas.

005840, RX And; Still maintaining an irregular type of variation averaging around a cycle of nine days between extreme magnitudes of 10.6 and 13.2.

020356, UV Per; Not observed at maximum during the interval of time covered.

020448, RV And; A semi-regular variable varying between magnitudes 9.1 and 11.3, in an average period of 175 days as deduced from three observed minima which are more sharply defined than the maxima.

021258, T Per; Practically no evidence of variation—none noted over many years of observation.

021403, *o* Cet; A well-observed maximum occurred about October 23, 1947, at magnitude 2.9, a full magnitude or more brighter than the maximum of 1946.

021558, S Per; Attained a maximum magnitude of 8.4 early in 1947, indicating a period of approximately 1,000 days between the last two maxima.

024136, TX Per; Period of 77 days well confirmed, range in magnitude from 9.8 to 11.7.

024356, W Per; A semi-regular variable with a well-defined minimum at J.D. 2432485, magnitude 11.1.

025050, R Hor; Well-observed maxima November, 1946, and December, 1947, with a range in brightness of nearly eight magnitudes.

032339, RU Per; Period of 181 days not confirmed, range in magnitude small, between 10.4 and 11.2.

032443, Nova Per; Slight fluctuations in magnitude between 12.7 and 13.0.

032362, U Cam; Variations irregular and observations show much scatter, probably due to red color (N-type star).

041619, T Tau; Although classed as an R CrB-type star (range 9.0 to 12.8) these observations show no marked decrease in light—observed range 9.6 to 10.5 only.

043562, R Dor; Variations irregular, between 5.1 and 6.6, period of 335 days does not appear to hold.

052372, RR Cam; Semi-regular variable, period of 123 days appears to be confirmed, but range in brightness is not more than one magnitude.

053326, RR Tau; Irregular, extreme variation 10.3 to 12.5, with a suggestion of several periods at work.

054319, SU Tau; R CrB-type, at maximum, ranging between 10.0 and 9.4.

054907, α Ori; Range in brightness between 0.2 and 1.5 in a long-term period of about 400 days.

055353, Z Aur; Considerable irregularity in period — 111 days value not holding.

055646a, RS Aur; Period of 172 days appears to hold.

055646b, SV Aur; Evidence of variation slight.

063462, RR Pic; This nova holds close to magnitude 10.8, with no appreciable change in magnitude during the past two years.

071044, L_2 Pup; Period of 141 days holds well, but light curve shows marked differences in form.

073520, Y Gem; Variation irregular between magnitudes 9.0 and 10.7—but not to 13th magnitude, as scheduled.

080165, RZ UMa; Semi-regular period of 135 days suggested, but range in magnitude between 9.0 and 10.0 only.

080319, RV Cnc; Little, if any, variation. Mean magnitude 12.2.

0808*35*, Nova Pup; Magnitude uniformly at 10.8.

0954*58*, RR Car; Semi-regular with suggested period of 160 days, range in magnitude 7.0 to 8.4.

115158, Z UMa; Period of 198 days appears to be confirmed, but variation small with irregularities.

122*967*, — Mus; Little, if any, evidence of variation. Mean magnitude 6.7.

132*477*, S Cha; Little, of any, variation. Mean magnitude 6.8.

145*971*, S Aps; R CrB-type star, began descent to minimum late in 1946; fainter than magnitude 15, not brighter than magnitude 14 by end of November, 1946.

153738, RR CrB; Double period appears to be in evidence, but range in variation too small to be well observed.

154428, R CrB; Dropped to minimum, magnitude 11.5, late in 1946, attained full brightness again in March, 1947, where it has since remained at 6th magnitude.

155526, T CrB; From magnitude 8.0 in July, 1946, the star gradually decreased in brightness to 9.8 in March, 1947, where it has since remained with slight variations—practically at the pre-eruptive stage.

160325, SX Her; This star, like Z Aurigae, with an assumed period of 103 days, appears not to maintain uniformity in period.

164403, TT Oph; A period of 61 days appears to prevail, but not with perfect regularity.

174*406*, RS Oph; This recurrent nova varied from magnitude 12.0 in July, 1946, to magnitude 10.2 in November, 1947, thus confirming previous semi-periodic fluctuations noted by Prager and others. The star requires close attention.

180445, DQ Her; This nova of 1918 varied irregularly between magnitudes 13.0 and 13.5.

181631, TU Lyr; Irregular variation between magnitudes 10.0 and 11.0.

182*616*, SS Sgr; An irregular variable, range 9.2 to 10.0 (N-type star).

183146, SZ Lyr; A period of 133 days appears to be confirmed, range 11.0 to 12.5.

184300, Nova Aql; Nova of 1901, varying between magnitudes 11 and 12.

184811, VW Aql; Varied irregularly from 11.7 to 10.3 over this interval of time.

1845*37*a, S CrA; Involved in nebulosity; variation irregular, between 11.8 and 12.6.

1855*37*a, R CrA; Like S CrA, involved in nebulosity, variation irregular, between 11.2 and 13.4.

1855*37*b, T CrA; See R and S CrA. Variation irregular, between 12.6 and 13.8.

1910*33*, RY Sgr; R CrB-type star. Began decrease to minimum in November 1946, to magnitude 13.5. Still at minimum in December, 1947.

191350, TZ Cyg; Period of 90 days does not appear to be confirmed, although estimates scatter considerably and variation in light is small.

191629b, AV Cyg; Period of 87 days appears to be confirmed. Range 10.2 to 11.6.

193428a, BG Cyg; Period of 292 days confirmed, range 10.0 to 12.0.

194632, Chi-Cyg; Maximum observed at magnitude 5.6 in June, 1947; range large, over eight magnitudes (see note on R Hor).

201437a, P Cyg; Slight variation, mean magnitude 5.0.

201520, V Sge; Variations irregular and sudden, extreme range 10.5 to 13.0.

203422a, RU Vul; Period 158 days confirmed. Minima more sharply defined than the maxima. Range 8.8 to 11.6.

203501, AE Aqr; Very peculiar star, maxima occur very suddenly and irregularly, occupying at times only a few hours. When observed brighter than magnitude 11, it should be followed at short intervals for several hours (a chart may be secured from the Recorder).

220912, RU Peg; Irregular—maximum observed in August, 1946, October, 1946, May, 1947, October, 1947, December, 1947.

221646, π_1 Gru; Little change in magnitude, not exceeding 0.2 magnitude (6.4-6.6).

225342, TV And; Period 115^d appears to be confirmed.

225745, VY And; Period of 149^d holds on approximately (a very red variable).

231040, TY And; Irregular, possibility of a 100-day periodicity.

232848, Z And; Varied fairly regularly between magnitudes 9.0 and 10.2. Maximum attained early in 1947.

233815, R Aqr; Maximum magnitude 6.7 reached in June, 1947, minima, approximately 11th magnitude, attained in December, 1946, and December, 1947, respectively.

234956, Rho Cas; J. L. Greenstein reports sudden spectral changes and suspects accompanying changes in magnitude. (See these Notes for January, 1948, showing light curve).

Observations received during January: A total of 3242 observations were received during January from 49 observers, as follows:

Observer	No. Var.	No. Ests.	Observer	No. Var.	No. Ests.
Ahnert, P.	21	40	Hartmann	167	185
Ancarani	19	22	Howarth	16	16
Ashbrook	1	2	Kelly	12	12
Bartlett	5	43	Kirchhoff	18	49
Bicknell	9	58	de Koch	114	476
Bogard	37	107	Loden	5	13
Brown	3	3	Luft	5	33
Cain	3	3	Mary	20	20
Caraioryis	6	14	Matthews	15	15
Chandra	200	297	Meek	22	115
Chassapis	20	24	Miller	18	24
Cragg	44	62	Oravec	53	161
Dafter	6	26	Park	2	2
Daley	8	8	Pearcy	34	37
Darling	12	39	Peltier	141	172
Elias	10	25	Penhallow	5	9
Escalante	45	61	Plybon	3	16
Estremadoyro	4	9	Renner	66	66
Fernald	329	801	Rosebrugh	15	122
Greenley	26	38	Seagroves	5	5
Harris	3	3	Sherman	18	25

Observer	No. Var.	No. Ests.	Observer	No. Var.	No. Ests.
Taboada	60	61	Weitzenhoffer	3	3
Thomas	6	7	Wells	5	5
Tifft	24	37	Wilmot	2	2
Webb	17	19			
			49	totals	3242

February 16, 1948.

Comet Notes

By G. VAN BIESBROECK

On January 19 two new comets were announced through the central bureau of astronomical telegrams at Harvard College, Cambridge, Mass. COMET MRKOS (1948 *a*). A. Becvar, director of the observatory at Skalmate Pleso, Czechoslovakia, announced the discovery there of an unexpected comet by Antonin Mrkos:

1948 Jan. 18.1944
Right ascension $16^h\,41^m.8$ Declination $+9°\,45'$
Magnitude 10—Object centrally condensed—Short tail.
Daily motion $3^m\,32^s$ east; $0°\,28'$ north.

This object was at once picked up in various observatories and within a week several orbits had been computed:

Computer	Nauer	Maxwell	Cunningham
Perihelion U.T.	Feb. 16.413	Feb. 15.576	Feb. 17.6750
Node to perihelion	61°43′	61°5′	62°.65615
Longitude of node	198 31	198 24	198.75962
Inclination	77 29	77 21	77.74656
Perihelion distance	1.5002	1.5037	1.495798

FIGURE 1

Comet 1948 *a*, from a 4-minute exposure on Jan. 7, 1948, by G. Van Biesbroeck.

From the last set of elements results the following ephemeris:

	α	δ	Mag.
	h m	° ′	
1948 March 2	19 44.8	+35 30	10.5
6	20 3.5	37 22	10.6
10	22.0	39 3	10.7
14	40.4	40 33	10.8
18	20 58.3	41 52	10.9
22	21 15.9	43 01	11.0
26	21 32.8	+44 02	11.1

When first seen here on January 20 the comet showed a well condensed coma some 10″ in diameter and a faint tail extending to a length of 7′ in position angle 255°. The brightness was estimated between 10th and 11th magnitude. Since then the comet has closely followed its predicted course with little change in appearance or brightness (Fig. 1). When last seen on the morning of February 8 it was still a 10th magnitude object. The perihelion distance being large no great physical activity is to be expected. The comet is best seen in the latter part of the night moving across the constellation of Cygnus in March and only slowly losing in brightness. It will probably be followed for several months afterwards.

Comet Wirtanen (1948 *b*). This comet was found at the Lick Observatory, Mt. Hamilton, California, by the same observer who last year discovered 1947 *h*. Although it was first recorded on January 17 the announcement of the discovery reached the Copenhagen Central Bureau after Mrkos' discovery on February 18 had come in, hence the designation 1948 *b*. The information broadcast was as follows:

1948 Jan. 17.31806
Right ascension $4^h\,37^m.9$ Declination +26° 29′
Magnitude 16—Diffuse with central condensation
Daily motion $0^m\,44^s$ east; 0° 14′ north.

That very faint, slow moving object was much less observed than 1948 *a* yet within ten days a preliminary orbit and an ephemeris were published by Cunningham (Berkeley).

Perihelion time	1947 Nov. 30.5679 U.T.	
Node to perihelion	341°.58519	
Longitude of node	87.24288	(1950.0)
Inclination	12.58515	
Semi-major axis	2.916841	
Eccentricity	0.459486	

Faint as this comet was at discovery it was already losing in brightness and will therefore only be accessible to powerful telescopes. But it is conveniently located in Auriga during March and will probably be followed until then.

Further details have been received concerning the visibility of the short-lived bright Comet 1947 *n* in the southern hemisphere. V. A. Estremadoyro of Chorrillos, Lima (Peru) has followed with the naked eye the development of the tail. By drawing the location on a map reproduced in Figure 2 both length and orientation of the tail were well recorded. On the last two days a 4-inch telescope was used since already on Dec. 20, the magnitude being estimated as 5.8, the object became difficult for the naked eye. The map shows also the location

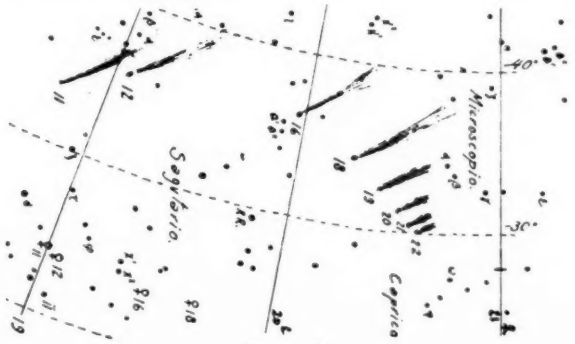

FIGURE 2

of the planet Venus on the same dates. The striking appearance of this object is well illustrated by the photographs secured by J. Bobone and M. Dartayet at the Cordoba Observatory (Argentina) and kindly transmitted by the former. On the 1-minute exposure (Fig. 3) obtained December 9 with the astrographic

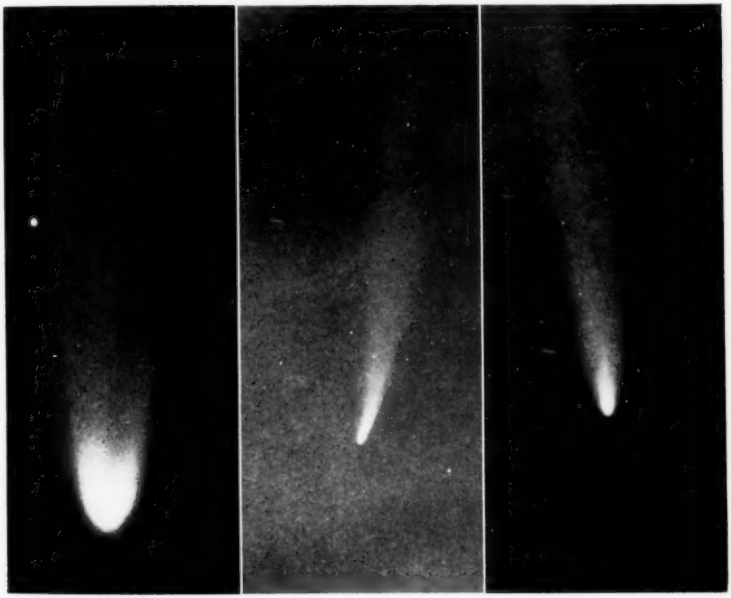

FIGURE 3 FIGURE 4 FIGURE 5

Comet 1947 *n*

Left: One-minute exposure by J. Bobone on December 9.
Center: Six-minute exposure by M. Dartayet on December 9.
Right: Four-minute exposure by J. Bobone on December 12.

telescope the paraboloid envelope of the head stands out clearly; the 6-minute exposure obtained simultaneously with a 5-inch camera (Fig. 4) shows the long extent of the tail and its fanshaped broadening as it curves away from the nucleus. The 4-minute exposure on December 12 (Fig. 5) with the larger instrument shows the finer structure of the tail. The total brightness had already dropped appreciably on that date and the decrease in luminosity accelerated during December. On January 20 when a last record of the comet was obtained by the writer all that was left of this bright object was a vague nebulosity of about 11th magnitude which was seen with difficulty at low altitude.

There are still several other comets under observation but all of them are too faint for ordinary telescopes and losing in brightness. The variable Comet Schwassmann-Wachmann No. 1 (1925 II) has been recorded several times as a minute coma not brighter than 17th or 18th magnitude; while changes in appearance are indicated no bright outburst has so far been noticed at this opposition. From previous experience such outbursts can be expected any time and a continuous watch is desirable.

Before long we may expect the recovery of Periodic Comet Forbes (1929 II) which is due at perihelion next September. F. R. Cripps gives the following search ephemeris:

	α	δ	
	h m	° ′	Mag.
March 6	14 7.5	−11 39	15.6
14	7.0	11 53	
22	5.9	12 0	
30	14 2.3	12 0	
April 7	13 57.0	11 53	14.6

It will of course require a powerful instrument to see this comet at first but it is expected to gain nearly three magnitudes by next summer. Early risers will have a chance to see a fairly bright morning comet in the beginning of March. As previously mentioned, Comet Bester (1947 *k*) will then begin to emerge from the sun's vicinity and probably reach naked-eye visibility. Cunningham's ephemeris for this comet is as follows:

	α	δ		
	h m	° ′	Mag.	Mag.
1948 Feb. 27	20 24.4	−14 49	5.0	2.5
Mar. 6	20 14.9	− 8 03	5.0	2.7
14	20 04.7	+ 0 59	5.1	2.9
22	19 51.6	13 27	5.1	3.2
30	19 30.9	30 23	5.2	3.5
Apr. 7	18 50.5	+50 26	5.5	4.0

The two columns of magnitude give the predicted values resulting from the hypothesis of a change in brightness according to the inverse fourth or sixth power, respectively, of the distance from the sun. Estimation of brightness by careful comparison with nearby known stars will give valuable information about the true nature of the change. On February 27 the comet rises only $1^h\,50^m$ befor the sun; by March 6 the difference is $2^h\,42^m$; by March 14 this difference becomes $3^h\,45^m$ so that the object is then well visible during the night.

Williams Bay, Wisconsin, February 11, 1948.

Communications and Comments

Under this heading we shall publish from time to time such material as does not properly fall under any of the established headings of this journal. Here, too, may be found, when occasion arises, articles which the editor may not be willing to give sanction to but which, nevertheless, may be provocative of thought along new lines.

"Electrical Meteors"

In the early history of meteoritics we find that meteors were widely believed, by scientists of the times, to be of an electrical nature. Developments in recent years have shown so many and varied electrical effects to be associated with meteors that one might almost say a cycle of thought was taking us back to this old idea. It may be well soon to take full stock of the new data to renew our certainty in our beliefs about meteors, a procedure which the writer believes will make certain some of our doubts and bring to light new avenues to explore. The following tissues of hypotheses form a list of some of the ideas that have crossed the writer's mind concerning "electrical meteors."

An old idea that meteors were a type of auroral discharge could be revived, that is, it would be possible in these days to argue reasonably that some of the phenomena associated with meteors are of an auroral nature and even that a certain class of rare meteors of hazy appearance are an auroral discharge.

Searching for further causes that might produce a streak of light in the upper atmosphere we may seize upon the recent suggestion that hydrogen atoms are emitted from the sun's surface, which take two to four days to reach the earth. This effect might apply to some peculiar problems of telescopic meteors some of which have enormously high speeds. Such atoms originating on the surfaces of stars might ionize to faint luminescence their path thru the upper atmosphere. Perhaps some of the atoms were slowed down in traversing cosmic electric and magnetic fields to account for telescopic meteors of various speeds.

It might be reasonable to assume that particles larger than atoms exist in space. Such particles or dust must be highly charged and, moving with meteoric velocity, would produce a telescopic meteor not by frictional burning but by ionizing the atmosphere in its path.

It is possible to imagine that telescopic meteors are streaks of luminescence occurring in the lower atmosphere which after being exposed all day to sunlight, heat, and rays, has all manner of recombinations of atoms occurring in it during the night. Crystallization of streaks of water vapor under the lowered pressure of the higher atmosphere might cause streaks of light by ionization. Having gone this far we may as well add that perhaps a certain stratum of the atmosphere can at times act like a gigantic Wilson cloud chamber. Rays and particles traversing this stratum would have water vapor condense on the ionized atoms in their path or cause an effect similar to the recent snow and rain-making

experiments. Such "foggy" paths illuminated by starlight might appear as the faintest of telescopic meteors.

It could be theorized that cosmic rays might cause a meteoric appearance by sometimes converting atoms in the upper atmosphere into contraterrene atoms. Such an atom flying off at the moment of its constitution would be annihilated in a streak of light besides producing considerable ionization.

A difficult problem is an explanation for the enormous cylinders of luminescence which a meteor produces. We can easily assume that a meteoric body must produce powerful electromagnetic microwave energy. Such energy would bring to luminescence the atmosphere because of its low pressure.

Though often bordering on the unreasonable and perhaps more entertaining than scientific, the writer feels that such ideas as herein proposed may stimulate speculation and interest.

VINCENT ANYZESKI.

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General Notes

Dr. H. A. Deslandres, formerly director of the Observatory of Meudon, died on January 15 at the age of ninety-four.

Dr. Charles Hetzler has been appointed Assistant Professor of Astronomy at Brown University. He began work in this position in February of this year.

Roy W. Delaplaine, since 1929 night-observer at the Sproul Observatory of Swarthmore College, died at his home in Swarthmore on 1948 February 12, at the age of 62. Mr. Delaplaine took almost ten thousand photographic plates with the 24-inch refractor, more than one-third of the total number taken since the instrument was put in operation in 1912.

Dr. Walter B. Huey, one of the charter members and a past president of the Joliet Astronomical Society, died on January 25, 1948, at the age of sixty-nine. Dr. Huey was an ardent amateur telescope maker and made his telescopes available to many. His interest in astronomy began in his youth when he lived near the Kenwood Observatory of Dr. George Ellery Hale.

The Rittenhouse Astronomical Society, of Philadelphia, held its monthly meeting on February 13, 1948, in Randal Morgan Physics Laboratory, University of Pennsylvania. The speaker was Dr. Bart J. Bok, Harvard College Observatory, whose topic was "The Center of Our Galaxy."

Astronomical Wall Chart,—This is the name given to a chart, 4 feet by 2 feet in size, designed to represent by means of diagrams and description the

essentials of elementary astronomy. Many of the questions which arise in the mind of nearly every one in beginning his reading in astronomy are answered succinctly and accurately on this chart. A few of the items delineated are the phases of the moon, an orbit of a comet, Saturn and its rings, the parallax of a star, the interior of the earth. There are others of equal interest. Moreover, the 94 known elements are listed with their characteristics. And, looking to the future, there is a time table for rocket ships, traveling at 15,000 miles per hour, and at twice that speed, to the moon, the several planets, and to the nearest star! Further description, price, and the opinions of several noted scientists are to be found in the advertising section of this issue. The chart is to be highly recommended for the worthy purpose for which it is intended.

Weatherwise,—Number I of Volume I, February, 1948, of a publication bearing the above title has just been received. It is to be issued bi-monthly by Amateur Weathermen of America, with headquarters at the Franklin Institute, Philadelphia, Pa. The name apparently has been taken from a quotation from Benjamin Franklin which appears at the opening of the issue, namely, "Some people are weatherwise but most are otherwise." The purpose of the magazine is to stimulate interest in weather and weather forecasting, both for the intrinsic interest and for the service which such interest may render in all communities. The subscription price is $3.00 a year.

All who enjoy studying any aspect of weather phenomena are eligible to membership and participation in the activities of Amateur Weathermen of America. Such persons should write to David M. Ludlum, Director AWA, Franklin Institute, Philadelphia 3, Pa.

An Ancient Solar Eclipse Record

In the Egyptian Museum at Turin is to be found a record, in the Coptic language, of a solar eclipse. The date of the eclipse is given in terms of the Coptic calendar which must be translated into the Gregorian calendar in order to have meaning for the present-day reader. This has been done by Edwin Brown Allen in a recent issue of the *Journal of the American Oriental Society*. He finds that the various items given in the inscription all agree with the circumstances of the eclipse of March 10, 601, of the Christian era, which is numbered 4307 in Oppolzer's "Canon der Finsternisse." This identification, being so definite, in turn fixes the date of the inscription itself.

The Duodecimal Society of America Prize

Mr. Harry C. Robert, Jr., of Atlanta, Georgia, was announced the recipient of the 1948 Award of the Duodecimal Society of America, at the Society's annual meeting held at the Gramercy Park Hotel on January 22. This is the fifth such award made by the Society, recognizing outstanding service to mathematical research with special relation to the duodecimal number system.

In announcing the award George S. Terry of Hingham, Massachusetts, chairman of the awards committee, referred especially to Mr. Robert's explorations in square sums of consecutive squares, about which very little was previously known, work with the Fibonacci Series, and his chairmanship of the Society's

mathematical research committee. Mr. Robert later addressed the meeting on "An Engineer Looks at Mathematics and Duodecimals," and his talk was followed by general discussion.

Previous award winners of the Duodecimal Society have been F. Emerson Andrews, of the Russell Sage Foundation, New York; George S. Terry, of Hingham, Massachusetts; the late F. Howard Seely, of Oakland, California; and Ralph H. Beard, of New York City.

A 20-inch Reflector for Krakow Observatory

With the receipt of a gift of $500 from the Polish National Home Association of Rhode Island on January 16, the half-way mark in the solicitation of funds for a 20-inch reflecting telescope for the University of Krakow Observatory has been passed, it was announced by Dr. Charles H. Smiley, director of the Ladd Observatory of Brown University and secretary of the National Books-for-Poland Committee, at a dinner in Providence, R. I., on that date.

Dr. Stephen P. Mizwa, director of the Kosciuszko Foundation of New York, said that the projected gift to the Polish University would give Poland its largest telescope. Dr. Stefan Piotrowski of the Krakow Observatory, who is to sail for home shortly, stated that the telescope would be used primarily in the photo-electric measurement of the brightness of eclipsing variables. The astronomer, who is a noted authority on eclipsing variable stars, has been conducting research at Harvard College Observatory this year on an Agassiz Fellowship provided by Harvard through the Kosciuszko Foundation.

The optical parts of the telescope are in construction by Stanley Brower of the Laboratory Optical Company of New Jersey and include an elliptical flat and a convex secondary mirror so that the completed instrument can be used either in the Newtonian or Cassegrainian form. They are expected to be finished next month.

A Request For Information

An attempt is being made to ascertain the total quantity of meteoritic material from the vicinity of the Arizona meteorite crater known as the Canyon Diablo fall. Unfortunately, no complete record was ever kept of the finds made in the crater area and apparently none at all since the publication of the Holsinger map in 1909. An extensive field survey is now being undertaken for the purpose of ascertaining in so far as possible the distribution of such meteorites as still remain in the soil of the region. To supplement the knowledge thus obtained information is also being sought regarding the amount of meteoritic material from this fall that is at present in the various collections of the world and in other situations.

In nearly all instances, the material from this fall bears the label "Canyon Diablo, Arizona." We are therefore asking those in charge of collections, and others who have knowledge of the whereabouts of specimens from this location, to cooperate by reporting to the American Meteorite Museum, Post Office Box 1171, Winslow, Arizona, the following information:

1. Name of location of collection.
2. Total number of Canyon Diablo meteorite specimens in the collection.

3. Total weight of specimen or specimens.

4. Individual weights of all specimens of 5 pounds or more.

5. The whereabouts and approximate size of any nickel-iron meteorite, the source of which is not certainly known. We may be able to establish its identity.

This information will be greatly appreciated and will contribute to a better knowledge of this most important of all known meteorite craters. A summary of the results of this survey and also of the field work now being done will be made available to all through publication.

Pittsburgh Convention of Amateur Astronomers

Of particular interest to all astronomy societies within the proposed Middle Atlantic Region of the Astronomical League, are the activities planned by the Amateur Astronomers Association of Pittsburgh for the two weeks from May 10 to 22. During that period, members of the Association plan to go "all out" in promoting their hobby, with a display of telescopes made by members, visits to Allegheny Observatory, and trips to other points of astronomical interest.

During the week-end of May 15-16, the Pittsburgh Association is inviting all other societies in the proposed region to meet with them in the Lecture Hall of Buhl Planetarium for an exchange of ideas and for the purpose of organizing the Middle Atlantic Region of the Astronomical League. All groups in southern New Jersey, Delaware, the District of Columbia, Maryland, Virginia, West Virginia, Kentucky, Ohio, Indiana, Michigan, and Pennsylvania are urged to make plans for sending delegations to this convention.

The Middle Atlantic Region will be the fourth such organization within the Astronomical League. The other regions already in existence are the Northeast, North-Central, and Northwest, and member societies of the League are planning the establishment of additional regions in other parts of the country.

Seven weeks after the May 15-16 regional meeting in Pittsburgh, the Astronomical League will hold its second National Convention early in July in Milwaukee. Further information about both meetings may be obtained from the Astronomical League, Science Service Building, Washington 6, D. C.

Meeting of Teachers of Mathematics

The National Council of Teachers of Mathematics will hold its twenty-sixth Annual Meeting at the Claypool Hotel in Indianapolis, Indiana, April 2 and 3, 1948.

Among the frontier thinkers in education in mathematics who will appear on the program are A. J. Kempner, University of Colorado; C. W. Newsom, Editor—*American Mathematical Monthly;* Philip S. Jones, University of Michigan; F. W. Kokomoor, University of Florida; Guy T. Buswell, University of Chicago; Raleigh Schorling, University of Michigan; W. W. Rankin, Duke University; F. Lynwood Wren, George Peabody College for Teachers; John R. Clark, Teachers College, Columbia University; Lois Knowles, University of Missouri; Philip Peak, Indiana University; Daniel W. Snader, University of Illinois; William Betz, Mathematics Specialist, Rochester Public Schools; Joseph A. Nyberg, Hyde Park High School, Chicago; Henry W. Syer, Boston University; Irene Sauble, Public Schools, Detroit; Mary Potter, Mathematics

Specialist, Racine, Wisconsin; Virgil Mallory, N.I.S.T.C., Montclair, N. J.; Rachel P. Kentston, Stockton H. S., Stockton, Calif.

More than fifty topics are listed on the program. The topics range from "Elementary Arithmetic in an Activity Program" to "Coordinating High School and College Mathematics. Although topics concerning the philosophy of teaching mathematics have not been omitted the emphasis seems to be on methods and special techniques in mathematics teaching. There will be a continuous showing of the latest visual aids in teaching mathematics.

Reservations may be made by writing directly to the Claypool Hotel, Indianapolis, Indiana.

The 200-Inch Telescope Adjustments

First test observations, preliminary to the work of making adjustments on the 200-inch telescope, have been made at the Palomar Mountain Observatory, Dr. Max Mason, Chairman of the Observatory Council at California Institute of Technology, said on January 18.

"These were only test observations, both visual and photographic, and the first of a long series that will have to be made as completion of the telescope progresses," Dr. Mason said. "In reality we were not observing at all but using stars as a source of light by which to further test the 200-inch mirror. We deliberately avoided taking pictures of objects of any particular interest. These test photographs were taken with the telescope at vertical position, at 60 degrees and at 30 degrees both north and south."

Dr. John A. Anderson, Caltech scientist who figured the 200-inch mirror and supervised its grinding and polishing, was the first Palomar observer, Dr. Mason said. Using a small reading glass for an eyepiece to peer at the image formed by the big mirror, he became the first person to actually observe with the telescope. Others who followed him included Dr. Ira S. Bowen, who will direct both Mt. Wilson and Palomar Observatories when the latter is completed; Dr. Edwin P. Hubble and Dr. Milton L. Humason of the Mt. Wilson staff; Dr. Russell W. Porter, who designed the observatory building and assisted in design of the entire telescope; Marcus H. Brown, who had charge of the Caltech optical shop during the 11-year grinding and polishing operation; Bruce Rule, project engineer; Byron Hill, construction engineer at the observatory; and Professor J. H. Oort, visiting astronomer from Leiden, Netherlands.

"We are very pleased to be able to get our first test photographs so soon," Dr. Mason said, adding that it was nearly a year after the 100-inch mirror was taken to Mt. Wilson before the first test pictures were obtained.

These first test observations were made in order to locate where the axis of the telescope cuts the photographic plate and to check the entire instrument under actual operating conditions. A great deal of additional completion work and adjusting remains to be done, Dr. Mason said, and other test observations will be made as this progresses. Because of the great amount of completion and adjustment work yet to be done, the telescope will not be ready to begin an actual research program until summer, he said.

Results of research done by the 200-inch telescope will be published in recognized astronomical journals and news stories will be released simultaneously with such publications.

New Astronomical Observatory at the University of Michigan

Erection of a new astronomical observatory, at a total cost of $260,000 and equipped with a 24-inch Schmidt-type reflecting telescope will be started soon at the University of Michigan, President Alexander G. Ruthven announced recently. The new observatory will be located in Stinchfield Woods, near Ann Arbor and near the University's new FM radio tower on Peach Mountain. Construction will be completed within the year, President Ruthven said. Completion of this observatory will make possible the continued development of the University's department of astronomy, already recognized for its outstanding research on the sun and on the spectra of stars. The McMath-Hulbert Observatory, operated by the University near Pontiac, is one of the world's centers for solar research. During the war, investigators at this observatory developed the bombsight used by the Navy, and also contributed valuable meteorological information used in predicting radio transmission conditions.

On the Ann Arbor campus, the University now has an observatory equipped with a 37-inch reflecting telescope. This observatory, erected in 1854, has been used in a long-continuing study of the spectra of stars.

The new observatory, President Ruthven explained, will be especially useful in expanding teaching facilities of the astronomy department. It will also be used in research, especially on the structure of galaxies and the Milky Way. It is probable that research will also be undertaken on objects within the solar system, including comets and asteroids.

With these observatories thus available for use by students and faculty investigators, the University will be equipped to work on almost any type of astronomical problem, Professor Leo Goldberg, chairman of the astronomy department, has explained. The University also operates the Lamont-Hussey Observatory in Bloemfontein, South Africa.

Erection of the new observatory has been made possible by a grant of $100,000 from McGregor Fund of Detroit. This amount together with funds already available for the purpose will provide for the completion of the observatory.

A two-story building will house the new telescope and will also include shop and utility rooms, offices, photographic darkroom, and a library. The dome for the telescope will be 28 feet in diameter.

The reflecting telescope will be built by the Warner and Swasey Co., of Cleveland. It will be a Schmidt-type telescope, based on an instrument developed in Germany in 1931. It will photograph at one time a field six degrees in diameter, roughly twelve times the diameter of the moon.

Book Reviews

University of Cincinnati Publication

The University of Cincinnati Observatory has recently completed its program of determining the proper motion of stars which was begun 40 years ago. The current catalog, listing 2,300 stars, supplements a first catalog put out by the Observatory just 25 years ago and listing 4,683 stars. The two catalogs record for nearly 7,000 stars such data as the precessions, secular variations, proper motions, and final positions. The work, done with an instrument known

as a meridian circle, was started in 1907 by the late Dr. Elliott S. Smith of the Observatory staff, aided by the late Dr. Jermain C. Porter, the Observatory's director from 1884 to 1930, and Dr. Everett I. Yowell, another former director now professor emeritus of astronomy at the University.

The most recent data were prepared for publication by Dr. Herget. Although the work was concluded in 1940, publication of the findings made since the 1922 catalog was delayed until now because of the war, during which Dr. Herget was on leave of absence from his local post to serve in Washington with the United States Naval Observatory.

Magnetic Declination in the United States

The above is the title of a new publication issued late last year. This publication is intended especially for land surveyors and others who use the compass. It contains an isogonic chart, which shows graphically the distribution of magnetic declination (variation of the compass) in 1945. There are also tables showing how the declination varies in the course of a day.

A copy may be secured for fifty cents by addressing the

Superintendent of Documents
Government Printing Office
Washington 25, D. C.

Techniques of Observing the Weather, by Benarthur C. Haynes, Chief of the Observations Section, U. S. Weather Bureau, Washington. (John Wiley & Sons, New York. $4.)

This volume treats a highly technical subject in a manner readily understood by the non-specialized reader. It is thus a "natural" for private fliers, amateur weather observers, farmers, and beginning students of meteorology; and will probably be widely used in high school, college, and training school classes, and for the instruction of such groups as the cooperative observers upon whose services the airlines rely so heavily.

Mr. Haynes' book bids fair to being the answer to a crying need for a really basic first step in the amateur's or hobbyist's approach to meteorology. With the book's help almost anyone should be able to master the use of meteorological instruments, interpretation of observed phenomena, the science of accurate reporting, and even the necessary lore for setting up a private workshop and observation station. As an aid to the understanding of weather components, Mr. Haynes devotes entire chapters to such fundamentals as the atmosphere, clouds, visibility, temperature, humidity, pressure, precipitation, and winds. He then progresses to means and methods of observation, with detailed instruction in the use of instruments, charts, and forms. Each step is fully illustrated for greater clarity. Necessary abstract material is covered, of course, but this is chiefly a practical book, designed to develop ability and knowledge in weather observations.

Throughout, techniques are presented in a simple manner, assuming only that the reader remembers the more elementary precepts of his high school physics, trigonometry, and algebra. Probably the most interesting parts of the book are those outlining actual observation methods — how station sites are selected, what instruments are used, recording and report forms, hydrometeor

symbols, the science of winds-aloft observations, and electronic meteorological observations. For those beginners who do not have access to a laboratory, an entire section is devoted to instructions for setting up a workshop. "Breakdown" diagrams are given of equipment easily made at home; and directions are included for the establishment of a functioning private weather station.

Mathematics as a Culture Clue and Other Essays, by Cassius Jackson Keyser. (Scripta Mathematica, Yeshiva University, $3.75.)

This is Volume I of the Collected Works of Cassius Jackson Keyser. It is a collection of twelve of the author's essays, biographical sketches, and book reviews. The fact that they are written as separate works, not intended for joint publication, is probably the reason for several instances of repeated ideas having many of the same illustrations and, in one case, almost the same wording for a half-page. (p. 5 and 101; p. 12, 110, and 272; p. 36 and 219.) Such repetition annoys the reader, whatever the reason for it.

The essay whose title was chosen as the name of the book is not, as might be supposed, a treatment of the cultural value of mathematical discipline. Its thesis is: "The type of Mathematics found in any major Culture is a clue, or key, to the distinctive character of the Culture taken as a whole." Keyser states that this essay is a rehandling of the facts and considerations first propounded by Oswald Spengler in "The Decline of the West," which Keyser believes "is, with perhaps a single exception, the most mind-stirring work of our time."

Mathematics and the Science of Semantics, another chapter, is a comprehensive review of Korzybski's "Science and Society." Keyser brings up some "queries, doubts, and reservations," but calls the work as a whole "the most momentous single contribution that has ever been made to our knowledge and understanding of what is essential and distinctive in the nature of Man."

Another essay concerns the first five of the ten volumes of the "Collected Papers of Charles Sanders Pierce." Keyser states that "it would be difficult to name works more worth reading than these." His aim is not to present a "review," but to give "a sense of the scope, depth, originality, brilliance, and gravity of Pierce's thinking as may lead the reader to make for himself a serious examination of the author's works."

One of the biographical sketches describes the Italian, V. F. D. Pareto, as an economist and sociologist as well as a mathematician. Keyser claims that "Pareto did more than any other thinker had done to advance Sociology from the status of a pseudo-science to that of a genuine science." Concerning William Benjamin Smith he maintains "Our country has had no greater scholar, no profounder or more productive investigator, no more versatile genius, and none more completely devoted to the higher interests of the human spirit."

In his essay on The Bearings of Mathematics the author states: "Among the major intellectual and spiritual concerns of mankind there is not one that could be rightly excluded from the purview of" a complete consideration of the bearings of mathematics. In his essay Mathematics and the Dance of Life he maintains that "Mathematics is an organic part of the Dance of Life," and that the art of the mathematician "is a living member of the family of arts together constituting the Art of human Life." "Normal" mathematicians, Keyser claims, are in general unaware of this. The inspiration for the name of this essay was

derived from Havelock Ellis' "The Dance of Life," a book which Keyer ranks "among those rare ones that are to be honored and revered as emancipators of the human mind."

In choosing quotations, I have deliberately selected those which, considered alone, appear to be overstatements. However, at the risk of being accused of overstatement myself, I would say that, in this volume, Keyser has substantiated his statements very convincingly.

Carleton College. KENNETH W. WEGNER.

Sunspots in Action, by Harlan True Stetson. (The Ronald Press Co., New York. $3.50.)

In the foreword to this volume, Nobel prize-winner Sir Edward V. Appleton says, ". . . In it [this book], the fascinating field of sunspot activity and its terrestrial consequences is explored and expounded by Dr. Stetson, who is himself a pioneer in this territory. Indeed, the reader could not have a more learned or a more friendly guide." One can hardly hope to improve on this brief description.

The book's 261 pages include the foreword, a preface, an excellent bibliography seven pages long, an appendix giving relative sunspot numbers month by month from 1749 to May, 1947, as well as annual means, and two indices, a name index and a subject index, besides 227 pages, sixteen chapters, of text.

The relation of sunspots to radio communication, radio prediction, the earth's magnetism and the northern lights, the weather, living things, and even the radio industry and the F.C.C. are discussed. The author's special interest in radio is shown by the appearance of the word, "radio," in the headings of five of the sixteen chapters. One might question whether a chapter on "radio and the Moon" rightfully belongs in a book on sunspots but the reader will find it interesting and not particularly out-of-place.

The material on "Predicting Sunspots" is especially interesting, presenting as it does at least seven different predicted times for the "next" sunspot maximum, which is now just past, here, or soon coming. Several different approaches to the problem of predicting sunspots are indicated, and the author points out weaknesses in a number of them.

The chapter on Sunspots, the Radio Industry and the F.C.C. explains briefly what frequency modulation is and what may reasonably be expected of it, and then dispassionately tells how a government bureau operated to "protect the public's interest."

There are the inevitable few errors that escape the proofreader's eye; for example, on page 6, "Were a message from the solar system to be sent to the outskirts of the galaxy for rebroadcasting back to us, we should have to wait a hundred *million* years for returned news." Possibly this represents a generous allowance for delays due to strikes!

The book should leave a good impression on a young person's mind . . . a feeling that not *all* of the answers are known, that some exciting and important work remains to be done.

CHARLES H. SMILEY.

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